

**EMERGENCY RESPONDERS' PERCEPTIONS OF ENVIRONMENTAL HEALTH  
HAZARDS AND PERSONAL PROTECTION IN RESPONSES**

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## Abstract

The generic qualitative study was an exploration of emergency responders' perceptions of environmental health hazards and the influence on decisions of personal protection during emergency responses. For this study, the focus was firefighters. Several prior scholars conducted research on mortality rates among firefighters, identifying a probable link between occupational exposures during emergency responses and the development of chronic health issues later in their careers. However, current literature lacks insight into the perceptions of firefighters regarding environmental health hazards in emergency responses and the influence of these perceptions on their decisions of personal protection. Risk perceptions are tied to safety behaviors and are thus important to the field of emergency management. Rational choice theory provided a framework for the analysis of firefighter risk perceptions. According to rational choice theory, individuals make the best decision available based on specific circumstances. Data collected for this generic qualitative study came from semistructured, in-person interviews with 17 firefighters in active emergency response roles working in the Pacific region of the United States. Other participation criteria included currently holding positions within a fire agency with primary duties encompassing the mitigation of emergency situations, such as firefighting, emergency medical response, hazardous materials response, and incident management. Transcripts of all audio-recorded interviews underwent coding to develop themes common among participants. Six themes emerged according to information explained in detail by study participants. In order of frequency, the themes included the following: (a) risk, (b) training and education, (c) awareness, (d) personal protective equipment compliance, (e) safety culture, and (f) personal protective equipment. Findings from this research study may provide insight into safety program development to reduce rates of injury and death among U.S. firefighters.

## **Dedication**

For my family, Anna, Xavier, and Mateo: Thank you for all the support and love during my journey to complete my degree. To my parents, Miguel S. Bautista and Esperanza Pacheco: Thank you for all the sacrifices you made to provide me with the opportunities to thrive. Thank you for all the life lessons and for helping me to develop a strong work ethic. Finally, I would like to dedicate this research to my grandmother, Maria Guadalupe Santoyo, who lost her battle with cancer this year and was unable to see this accomplishment come to fruition.

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## CHAPTER 1. INTRODUCTION

### Background of the Study

The occupation of a firefighter is inherently dangerous (Jahnke, Poston, Jitnarin, & Haddock, 2012). Firefighters respond to various types of emergencies that place them in harm's way, ranging from medical emergencies to hazardous materials incidents (Phelps et al., 2017; Smith, Eldridge, & DeJoy, 2016). The emergency scenes themselves are dynamic. It is this constant change within the emergency scene that exposes firefighters to a variety of hazards, increasing the risk of injury or death. Even when the emergency is abated, health hazards linger in the form of multiple toxic and carcinogenic products of combustion found in the overhaul phase of fire extinguishing operations (Maglio, Davis, Allen, & Taylor, 2016). In overhaul operations, firefighters search for fire in concealed spaces within a structure. During this activity, firefighters face exposure to higher levels of toxins due to variances in the use of proper respiratory protection (Gainey et al., 2018).

The risks associated with the occupation of firefighting are substantial compared to risks of other professions because of the firefighters' exposure to numerous hazards (Rodríguez-Garzón, Martínez-Fiestas, Delgado-Padial, & Lucas-Ruiz, 2016). Understanding the hazards that firefighters face is necessary to comprehend the levels of risk experienced during the response. Despite the hazards associated with the occupation, risk perception among firefighters has received limited attention from researchers (Jahnke et al., 2012; Rodríguez-Garzón et al., 2016).

The topic studied was emergency responders' perceptions of environmental health hazards and the influence those perceptions have on emergency responders' decisions regarding personal protection in emergency responses. For this study, the emergency responder group used

was firefighters. Researchers have established a causal link between occupational exposures and illness in firefighters (Daniels et al., 2015). Current literature lacks insight into the perceptions of firefighters regarding environmental health hazards in emergency responses and the influence these perceptions have on decisions for personal protection. For example, Jahnke et al. (2012) gathered firefighter perspectives of health concerns but did not explore the reasoning behind the lack of personal protection use during responses.

Firefighter perception is a relevant issue within the field of emergency management. Research studies have indicated that there are occupational risks to firefighters outside of the immediate threats of fighting fires in burning buildings (Harrison et al., 2017). Findings from a meta-analysis of several years of studies on firefighter cancer rates showed these individuals had an increased risk of developing cancer compared to the general population (Harrison et al., 2017). In a study conducted on the relationships for select cancer and noncancer health outcomes among firefighters, Daniels et al. (2015) discovered modestly increased mortality risks for firefighters due to work exposures. Among the 19,309 male firefighters included in their study were 1,333 cancer deaths and 2,609 cancer incident cases (Daniels et al., 2015). The researchers examined eight types of cancer and four noncancer outcomes, concluding that there was a causal link between firefighting and chronic health conditions. Research studies on cancer development related to occupational exposure to firefighters show firefighters exposed to carcinogens through a combination of routes targeting organs (Gainey et al., 2018; Moore et al., 2018). Among research conducted over the last 13 years, scholars have found exposures to environmental hazards have chronic effects on the health of firefighters (Fent et al., 2018; Jahnke et al., 2012).

With the increased knowledge of health hazards encountered during emergency responses, injury and death rates among firefighters are consistently high in the United States

(Poplin et al., 2015). In addition, risk-taking behavior persists within the profession, and compliance with the use of personal protective equipment (PPE) and respiratory protection continues to be a challenge (Maglio et al., 2016). To understand gaps in safety behavior, there is a need to increase understanding of safety perceptions among firefighters of the environmental health hazards encountered in emergency responses. Such understanding can provide insight into how these perceptions influence firefighters' decisions regarding personal protection.

### **Need for the Study**

Within the emergency management field, leaders and scholars have made progress in providing a better understanding of the environmental health hazards in emergency responses (Glass, Pircher, Del Monaco, Hoorn, & Sim, 2016). In responding to emergencies such as structural fires and hazardous material incidents, workers are exposed to various health hazards (Anderson, Harrison, Yang, Wendorf Muhamad, & Morgan, 2017). The nature of emergency response exposes firefighters to various mixtures of particulates, gases, mists, and fumes, both organic and inorganic (Fent et al., 2018). Researchers have established a causal link between occupational exposures and illness among firefighters (Daniels et al., 2015). What is not yet fully understood is the firefighters' perceptions of environmental health hazards and how these perceptions influence personal protection during responses. Perception of risk is important in the field of emergency management because of research showing an association between risk perceptions and injury and safety behavior (Prati et al., 2013). When an individual's associated level of threat to risk is high, the person's perception of this risk influences health behaviors (Ferrer et al., 2018). Thus, it appears that risk perception does predict protective motivation among individuals (Ferrer et al., 2018).

In the field of occupational safety, there is what is called the hierarchy of controls applied to reduce risks of injury or death (Burk, 2016). The hierarchy of controls incorporates five steps: elimination, engineering, administrative procedures, employee training, and PPE (Morris & Cannady, 2019). Occupational health specialists utilize these controls after gaining an understanding of the severity of the risks and the appropriate risk-reduction measures (Burk, 2016). In most occupations, administering these controls can prevent employee injury and death. In the profession of firefighting, however, applying these controls presents unique challenges. First, the only ways to eliminate the hazard are not to respond to the emergency or to prevent the emergency from ever occurring. Second, fire departments cannot engineer safeguards like those utilized in a manufacturing plant because the workplace of a firefighter is dynamic and mobile. Before applying the final three hazard controls, safety program managers need to understand the gaps in safety culture to properly address the root causes of noncompliance (Poplin et al., 2015).

This study centered on firefighters' perceptions of risk during emergency responses. Also explored were firefighters' understanding of the environmental hazards they face during responses, and how perceptions influence their decisions in personal protection use during responses. Insight on firefighters' perceptions can help identify common themes and gaps in understanding of risks associated with emergency responses. By understanding how these perceptions influence decisions about PPE compliance during emergency responses, leaders can develop and implement training to minimize occupational risks for firefighters and change safety culture within the profession (Maglio et al., 2016).

### **Purpose of the Study**

The purpose of this study was to explore the perceptions of firefighters regarding environmental health hazards and how these perceptions have an influence on personal

protection use during responses. Firefighters demonstrate altruism through helping others, spreading goodwill, and working at restoring social order (Prochniak, 2014), the consequences of which may not become apparent until much later (Prochniak, 2014). Gaining an understanding of firefighters' perceptions of personal protection equipment may provide insight on gaps in risk perception, which increase firefighters' exposure, leading to injury and death. Risk perceptions emerge from an individual's judgments and evaluations of the potential hazards, causing them harm (Joseph & Reddy, 2013). Risk perception is associated with injury and safety behavior (Prati et al., 2013). Individuals are unique and perceive risk differently; for this reason, it is essential to identify personal variables that influence the perception of risk (Rodríguez Garzón et al., 2016). The consistent level of injuries and death in the U.S. fire service reveals the need for an understanding of how individual perceptions influence emergency response decisions, which may have immediate or delayed consequences.

There is significant literature regarding occupational exposure during emergency response that leads to an increased risk of certain types of cancers (Fent et al., 2018; Jahnke et al., 2012; Maglio et al., 2016; Moore et al., 2018). However, literature is lacking regarding the risk perceptions of firefighters during emergency responses and how those perceptions influence PPE compliance (Maglio et al., 2016). Findings from this study can provide emergency response officials with an understanding of firefighters' perceptions of risk and how these perceptions influence safety decisions during emergency responses. Leaders can develop and implement safety training based on this knowledge to attempt to minimize occupational risks for firefighters. This study can inform safety and risk management in the field of emergency management, specifically focusing on safety perceptions that influence safety behavior within the U.S. fire service.

## Significance of the Study

The significance of the following study is that it provides a better understanding of the gaps in firefighters' perceptions of hazards encountered during emergency responses to inform the field about the influences on PPE decisions during emergency responses. Understanding the gaps in safety perceptions is an important step in injury prevention. Research has indicated that perceived risk and acceptable risk are associated and open to prediction (Slovic, 2016). Risk perception can be subjective because individuals define the concept of risk differently (Hahm, Knuth, Kehl, & Schmidt, 2015; Slovic, 2016). The risk equation incorporates the following considerations: uncertainty, dread, catastrophic potential, controllability, equity, and risk to future generations (Slovic, 2016). There is an inverse relationship between perceptions of risk to the anticipated benefit, as influenced by an individual's feelings regarding the specific hazards (Slovic, 2016). Kosla (2015) found an association between risk-taking occupational identities and unique understandings of risks either encouraged or discouraged by professional risk-taking. Insight into the firefighters' perceptions of safety hazards indicates themes that are different from the other occupations and explain firefighters' safety behaviors during emergency responses.

Rational choice theory served as a framework to discover the reasons for individuals' decisions when faced with choices and whether the individual's beliefs, preferences, and constraints drive these choices, as described by Manzo (2013). For this study, rational choice theory applied to firefighters in an emergency response. Rational choice theory explains individuals' actions given their conscious mental state (Hampsher-Monk & Hindmoor, 2010). Applications of rational choice theory have been more common in the social sciences and criminology sectors, but there has not been significant application in the field of emergency management (Gelder & Vries, 2014). Individuals make a rational choice because they believe it

is the best option based on time constraints, personal beliefs, and desired outcomes (Hampsher-Monk & Hindmoor, 2010). Compared to the general population, firefighters voluntarily place themselves in dangerous situations, something considered a rational action within the profession (Prochniak, 2014). The expectation is for firefighters to respond to emergencies without hesitation (Jahnke et al., 2012), as delayed action can result in civilian injury or death. There is an expectation among firefighters to do what is necessary, which involves placing themselves at risk to save lives (Scarborough, 2017).

The focus of this study was firefighters' perceptions of environmental health hazards, and the influence these perceptions have on personal protection during responses. This study expands the application of rational choice theory into the field of emergency management by focusing on responders' decisions regarding personal risks and exposure to environmental health hazards. Insight emerged from identifying firefighters' perceptions on these two issues, and if there are influences based on perceptions of risks and the sense of urgency during the response (Rodríguez-Garzón et al., 2016). The research further expands the use of rational choice theory and shows its application in a field not yet explored in depth. By gaining an understanding regarding specific situations in which firefighters justify their acceptance of risk and exposure to environmental health hazards, scholars can discover if rational choice theory is applicable to the field of emergency management (Rodríguez-Garzón et al., 2016).

The results from the following study contribute to the existing knowledge in the field of emergency management in a practical capacity. Emergency response is one function in the field of emergency management and one of the most dangerous to personnel, given the unpredictable nature of the environment (Rodríguez-Garzón et al., 2016). The emergency response phase comprises a variety of risks that range in severity. Gaining an understanding of how firefighters

perceive risks and how these perceptions impact their decisions will provide information to emergency response leaders on how to protect their personnel. Among past knowledge and research of occupational exposures to firefighters, it is clear that s face exposure to environmental health hazards that cause chronic health conditions in later years (Daniels et al., 2015; Fent et al., 2018; Glass et al., 2016).

The purpose of the study, then, was to explore firefighters' perceptions and how they influenced decisions on personal protection during emergency responses. The goal was to gain insight into safety perceptions and how those perceptions influence the decisions firefighters make based on their situation. Also explored were the potential environmental health hazards and how firefighters determine the level of personal protection in emergency responses. This information can provide emergency response leaders with an understanding of common themes in participant responses to identify gaps in risk and safety management training programs (Maglio et al., 2016.). The findings are important to the field, because gaining this understanding may aid in the development of training and policies that can reduce the number of personnel experiencing chronic health conditions from responses in later years (Maglio et al., 2016).

### **Research Questions**

The following research questions guided the study:

**RQ1.** What are emergency responders' perceptions of environmental health hazards in emergency responses?

**RQ2.** How do risk perceptions influence emergency responders' decisions in the use of personal protection in emergency responses?

## Definition of Terms

To assist with the consistent application and interpretation of the terms used in this study, the following definitions apply.

**Firefighter.** A firefighter is an emergency responder who attends to fire and rescue emergency calls as a member of a team (International Fire Service Training Association [IFSTA], 2013).

**Emergency response.** An emergency response follows someone calling 911 and initiating a fire department response (IFSTA, 2013).

**Environmental health hazards.** Environmental health hazards are those that pose a threat of injury and/or death at an emergency scene (IFSTA, 2013).

**Flashover.** A flashover is a rapid transition of fire from the growth stage to the fully developed stage (IFSTA, 2013).

**Gross decontamination.** Gross decontamination is the physical or chemical process of reducing and preventing the spread of contamination from persons and equipment after structure fire responses, normally conducted on the fireground prior to clearing the scene (IFSTA, 2013).

**Hazardous materials incident.** Hazardous materials incidents, or hazmat incidents, are emergency calls involving hazardous chemical releases that are dangerous to human health and the environment (IFSTA, 2013).

**Immediately dangerous to life or health.** According to the Occupational Safety and Health Administration (OSHA) and National Fire Protection Association (NFPA), immediately dangerous to life or health (IDLH) is a respiratory hazard that has immediate, irreversible, and debilitating effects on a person's health and may result in death (IFSTA, 2013). Examples

include smoke or other poisonous gases at sufficiently high concentrations, environments to which firefighters face consistent exposure during emergency responses (IFSTA, 2013).

**Motor vehicle accident.** In the context of this study, motor vehicle accidents are traffic collisions requiring emergency response, exposing firefighters to automotive chemicals and other safety hazards (IFSTA, 2013).

**Personal protective equipment.** Also known as turnout clothing or bunker gear, PPE is a general term for the equipment worn by fire and emergency services responders. PPE consists of a jacket, trousers, and boots with three components: an outer shell, a moisture barrier, and a thermal barrier. PPE also includes helmets, protective gloves, protective hoods, and eye and hearing protection (IFSTA, 2013).

**Salvage and overhaul.** Salvage and overhaul are the fireground operations after extinguishing the fire, when firefighters search the structure for signs of hot spots that may cause the structure to reignite. This process may involve the removal of building materials such as drywall and insulation in search fire extension. Salvage and overhaul operations normally occur in IDLH environments (IFSTA, 2013).

**Self-contained breathing apparatus.** A self-contained breathing apparatus (SCBA) is a respiratory device worn by rescue workers, firefighters, and others to provide breathable air in an IDLH atmosphere (IFSTA, 2013).

**Station/work uniform.** Also referred to as a Class B uniform, a station/work uniform is a fire station duty uniform worn by firefighters; it is normally made of Nomex flame-resistant material and worn under firefighter turnouts (IFSTA, 2013).

## Research Design

This study followed a qualitative methodology with a generic design. The use of qualitative methodology is appropriate when the goal is to gain a particular group's insight and understanding while conducting specific activities (Leung, 2015). As the research centered on gaining insight into the perceptions of firefighters to environmental health hazards and personal protections in responses, a qualitative approach was appropriate (Woodgate & Busolo, 2015). According to Percy, Kostere, and Kostere (2015), "Generic qualitative inquiry investigates people's reports of their subjective opinions, attitudes, beliefs, or reflections on their experiences, of things in the outer world" (p. 78). The focus of this study was on safety perceptions as they pertained to environmental health hazards encountered by firefighters, as well as how the perceptions influence decisions regarding personal protection in emergency responses. The opinions of firefighters provided insight into the formation of their perceptions of hazards and how these perceptions influence safety behavior. Following data analysis, themes emerged as a means to address gaps in safety behavior in the field.

Data collection was through semistructured, in-person interviews with research participants. In-person interviews are an appropriate data collection method when the goal is to gain a broad range of opinions, ideas, and reflections (Percy et al., 2015), in this case, on safety perceptions and occupational exposures. In addition, semistructured interviews are a means of collecting data in a generic qualitative design (Percy et al., 2015). Field experts who had knowledge of firefighter occupations and/or had previous experience in the role individually reviewed the proposed interview questions, with their feedback subsequently used to craft final questions.

Analysis of the data entailed the use of a thematic analysis with constant comparison. Transcriptions of each interview enabled the coding and clustering of common themes. Thematic analysis with a constant comparison approach was appropriate for developing common themes in firefighter safety perceptions that influence safety behaviors. Each transcript underwent analysis, with subsequent interviews compared to previously analyzed data, a process described by Percy et al. (2015). Upon identification of each theme, analysis of the theme and its significance took place. This process continued until no new themes emerged, thus achieving data saturation.

### **Assumptions and Limitations**

The following section contains a discussion of the assumptions and limitations in this study, identifying the source of these assumptions. This section presents three assumptions applicable to this study—methodological, theoretical, and topic-specific—followed by the limitations of the study.

#### **Assumptions**

**Methodological assumptions.** Data collection was by means of conducting semistructured interviews with participants. Open-ended interviews are the most successful to develop influence diagrams and models depicting participants' knowledge, attitudes, beliefs, values, and perceptions (Slovic, 2016). The research focus was on the firefighters' perceptions of environmental health hazards and how those influences affected their decisions on personal protection during responses. This study was a means to gain insight into these perceptions; as such, in-person interviews were the most effective. Researchers approach in-person interviews with the assumption that participants will tell the truth and fully participate. Difficulties may emerge during interviews due to a researcher's inability to build rapport with participants (Roulston, 2014). Overcoming this risk entailed taking time during each interview to explain the

scope of the research, describe the means of protecting each participant's identity, and actively listening to interview responses. Another assumption was that research participants had vast knowledge relative to the research topic (Roulston, 2018). Following population identification and screening, participants selected were those with the ability to provide knowledge and experiences to assist with answering the research questions.

**Theoretical assumptions.** The concept of rational choice theory is that individuals will decide on an action based on the circumstances faced, which they tie into their desired outcomes and beliefs (Dietrich & List, 2013). Therefore, a combination of factors influences individual choices. Firefighters believe they must accept the risks that come with the occupation; in some cases, this means accepting that their actions may result in injury or death (Maglio et al., 2016). Based on this belief, firefighters take certain risks that can potentially put themselves and their colleagues in danger (Rodríguez-Garzón et al., 2016). There has, however, been limited exploration into firefighters' perceptions of risk and the influence on decisions made on the fireground; therefore, this study expanded scholarship on the influence perceptions have on safety decisions on personal protection.

**Topic-specific assumptions.** A topic-specific assumption was that firefighters are aware of a causal link between occupational exposures from firefighting and cancer (Phelps et al., 2017). Over the last decade-plus, literature on the subject has appeared in various platforms, such as occupational journals and training conferences. Because this causal link is not a new subject, it is reasonable to assume that firefighters are aware of the risks associated with occupational exposures during emergency responses and recognize the need for measures to reduce these exposures. Therefore, an assumption was that with a higher level of education on the topic, fire departments would have implemented proactive measures to protect personnel from occupational

exposures (Rodríguez-Garzón et al., 2016). Another assumption was that if firefighters were aware of this health risk, they would take proactive measures in compliance with safety procedures and ensure their colleagues were doing so, as well. Exposures from emergency responses are minimized when firefighters use PPE; however, recent research shows that PPE usage among firefighters is not universal (Gainey et al., 2018).

### **Limitations**

**Design flaw limitations.** Limitations were apparent in this research study. Firefighters who took part in the study did so voluntarily. From the initial volunteers, snowball sampling was a means to obtain additional participants. Recruitment was limited by the pool of acquaintances a participant had and the proactive nature of potential recruits to ask others to participate in the study. Volunteers were thus more health-conscious and actively involved in anticancer initiatives within their agencies and more likely to be proactive in participating in research studies. Although there were challenges with recruitment, a diverse collection of firefighter responses ultimately informed the research.

**Delimitations.** The goal of this study was not to generalize the perceptions of firefighters regarding environmental exposures during emergency responses. This study was not an investigation of the types of exposures faced during emergency responses. There was no intent to prove cancer was a result of exposures through the firefighter occupation. Rather, the objective was to gain insight into the safety perceptions of firefighters during emergency responses and how those safety perceptions influenced the use of PPE during emergency responses. Understanding these perceptions of safety enabled the researcher to identify common themes among firefighters for compliance or noncompliance with the use of PPE. Emergency response

officials may use this information as they develop safety programs to overcome gaps in safety behavior.

### **Organization of the Remainder of the Study**

The organization of this dissertation is in five chapters. Chapter 2 presents the supporting literature for the study in the areas of environmental health hazards in emergency responses, chronic illnesses associated with occupational exposures in firefighting, behavioral theories, heroism, risk perceptions, and risk management. Chapter 3 includes a discussion of qualitative research with a generic design to justify the selection of the research design. Steps to ensure validity, credibility, and reliability are components of the chapter, as are the methods of data collection and data analysis. Chapter 3 concludes with ensuring the protection of human subjects in research. Chapter 4 presents the data collected in the study and an analysis of that data; finally, Chapter 5 provides conclusions and recommendations for future research.

## CHAPTER 2. LITERATURE REVIEW

The literature review provided the basis for a study of firefighter perceptions of environmental health hazards and how they influence decisions about personal protection during emergency responses. Firefighters face exposure to various health hazards when responding to fire scenes (Fent et al., 2018) with the use of PPE reducing this exposure (Gainey et al., 2018). Recent studies have shown that compliance with the use of PPE among firefighters remains a challenge (Gainey et al., 2018), perhaps due to risk perceptions of occupational health hazards, which researchers have found to be associated with injury and safety behavior (Prati et al., 2013). The following literature review contains an examination of relevant research studies, texts, and peer-reviewed journal articles regarding behavioral theories, safety behavior, safety perceptions, firefighter hazards, and risk management as they pertain to the safety perceptions of firefighters regarding environmental health hazards during emergency responses.

### Methods of Searching

Online databases searched for relevant scientific articles were: Academic Search Premier, Business Source Complete, SAGE Research Methods, SAGE Knowledge, SAGE Journals Online, and Science Direct. Keywords used for the literature search were *firefighter risks*, *firefighter injuries*, *firefighter deaths*, *fire exposures*, *fire toxicology*, *firefighter exposures*, *firefighter cancer*, *firefighter safety*, *safety perception*, *risk perception*, *heroism*, *altruism*, *risk-taking behavior*, *behavioral theories*, *rational choice theory*, and *risk management*. Relevant statistical information came from U.S. fire service organizations such as the National Fire Protection Association (NFPA) and the United States Fire Service Administration.

## Theoretical Orientation for the Study

This study centered on firefighters' perceptions of environmental health hazards and their influence on decisions regarding personal protection during emergency responses. Three behavioral theories merited consideration concerning their appropriateness for application into the field of emergency management. Following the examination of rational choice theory, health belief model, and theory of reasoned action, rational choice theory emerged as the best framework for this study.

Rational choice theory focuses on the choices a rational person will make based on all components of a given situation (Manzo, 2013). At its core, rational choice theory helps to explain individuals' actions given their conscious mental state (Hampsher-Monk & Hindmoor, 2010). Rational choice is an action taken because an individual believes it is the best option available based on time constraints, personal beliefs, and desired outcomes (Dietrich & List, 2013; Hampsher-Monk & Hindmoor, 2010). Rational choice theory indicates that the decision-making process entails a comparison of all choices by analyzing the benefits and costs of each, with the alternative with the most desired outcome chosen (Broda, Krüger, Schinke, & Weber, 2018). Although placing oneself in dangerous situations is not a rational act among members of the general population, firefighters must respond to emergencies without hesitation, in this way risking their own lives to save others (Maglio et al., 2016).

Researchers have provided insight into the decision-making of individuals, showing that people tend to make decisions based on what they consider rational (Baillon, Bleichrodt, Liu, & Wakker, 2016). Of course, such perceptions are subjective. Researchers use rational choice theory to understand how rational individuals behave when presented with choices. The assumption with rational choice theory is that individuals make decisions for rational reasons

(Mussel, Goritz, & Hewig, 2013). Firefighters work in an environment that is more hazardous than the ordinary workplace and are up to four times more likely to experience work-related injuries as compared to the general worker (Phelps et al., 2017). Although rational persons would likely not place themselves in dangerous situations, such behavior is an occupational expectation of firefighters. With this expectation to act, firefighters hold perceptions that differ from the ordinary person on what is considered rational behavior (Baillon et al., 2016).

Firefighters must fulfill societal expectations through a duty to act (Maglio et al., 2016). At training academies, firefighters learn they must have the courage to act, be selfless, and, in some cases, make the ultimate sacrifice to save a life (Gillani & Atif, 2015). One of the arguments regarding rational choice theory is that individuals sometimes act altruistically (Paternoster, Jaynes, & Wilson, 2017). Even so, there is a gap in knowledge regarding how altruistic behavior is a variable in rational choice because the focus is on the well-being of others instead of oneself. Current research has indicated that altruistic behavior is intentional and voluntary (Lemieux, 2014). Altruism can be embedded in an individual's beliefs, especially for people in public safety roles, because of their moral obligations (Zinn, 2015). Individuals gather information from others, their environment, or their own actions to fulfill their wishes (Muntanyola-Saura, 2014).

Firefighters face a moral obligation to carry out altruistic acts (Rodríguez-Garzón et al., 2016). Altruistic behavior is visible through firefighters' primary focus on the safety and well-being of both the general public they serve as well as their fellow firefighters (Wooding, Cormier, Bernstein, & Zizzi, 2018). Firefighters exemplify altruism through service to the community, sometimes at great physical risk. Firefighters willfully enter hazardous environments and engage in hazardous situations to mitigate the danger and protect the community (Smith et

al., 2016). This concern for others at the expense of self could be another factor that influences choices in personal protection meriting further research. Because of this societal expectation, the actions of an emergency responder during an emergency pertain to rational behavior and need additional scholarly inquiry.

### **Review of the Literature**

The purpose of this study was to explore the understanding of firefighters' perceptions of environmental health hazards and how these perceptions influence personal protection use during responses. The literature reviewed research on the health hazards firefighters face during an emergency response, as well as influences that form hazard perceptions during an emergency response. Current research reviewed pertained to occupational health hazards during an emergency response and the effect on firefighters' health; occupational illnesses experienced by firefighters; risk perceptions; heroism, altruism, and the effect on decision-making; behavioral health theories; and rational choice theory and human behavior. Following an exploration of the current literature was the identification of gaps in knowledge.

### **Occupational Hazards in Emergency Responses**

Firefighters' job duties include some of the most hazardous operations of any profession (Smith et al., 2016). The rate of injury for a U.S. firefighter is higher than that for the vast majority of U.S. workers (Prati et al., 2013). The U.S. Fire Administration, NIOSH, and NFPA report 70 to 100 on-duty firefighter deaths each year (American Society of Safety Engineers, 2015; Fahy & Molis, 2019). NFPA's 2015 survey confirmed these numbers, indicating 68,085 annual on-duty injuries among career and volunteer firefighters (Phelps et al., 2017). Firefighters in the United States spend approximately 39% of their work activity battling structure fires (Easter, Lander, & Huston, 2016). The greatest exposure to environmental health hazards

emerges during several phases of fire-suppression activities (Maglio et al., 2016). Health effects from these exposures can be immediate or not develop until years or decades later. During an emergency response, firefighters face hazardous environments containing asphyxiants, irritants, allergens, and carcinogens (Fent et al., 2018; Glass et al., 2016). Accordingly, the World Health Organization International Agency for Research on Cancer reported firefighters' exposure to carcinogens (Easter et al., 2016). This mixture of chemicals encountered during emergency responses is potentially a contributing factor to a firefighter's increased risk of cancer (Fent et al., 2018).

During fire suppression activities, firefighters receive heavy exposure to chemicals and particulate matter (Baxter, Hoffman, Knipp, Reponen, & Haynes, 2014). Smoke particulates during emergency responses may transfer by inhalation or contamination of skin or clothing through direct contact (Fabian et al., 2014). Underwriters Laboratories found that firefighters' gloves and protective hoods become contaminated during emergency responses by a wide range of harmful organic and inorganic compounds that are known carcinogens (Alexander & Baxter, 2016). Significant chemical exposures posing health threats to firefighters may include polycyclic aromatic hydrocarbons, which form from incomplete combustion of organic materials (Kirk & Logan, 2015). Smoke particles are products of incomplete combustion often found in structure fires. An analysis of combustion products showed firefighter exposure to high concentrations of harmful chemicals during post-fire settings (Baxter et al., 2014). In addition, research has shown many of the chemicals found in smoke particulates may have adverse cardiovascular implications (Fent et al., 2018). Exposures to multiple chemicals could have a negative health impact on individuals, especially if the chemicals affect the same organs (Fent et al., 2018).

Among the smoke particulates present during structure fires are the following toxins: ammonia, carbon monoxide, hydrogen cyanide, hydrogen sulfide, nitrogen dioxide, sulfur dioxide, polycyclic aromatic hydrocarbons, and phthalate esters (Fabian et al., 2014). Acute exposure to these chemicals can have immediate health effects or result in the development of chronic health illnesses (Fabian et al., 2014). The following is an overview of the potential health impacts resulting from exposure to these chemicals.

**Ammonia.** This chemical causes irritation to the skin, eyes, and upper and lower respiratory tract. Exposure can lead to respiratory conditions such as bronchitis, cough, shortness of breath, wheezing, and chest pain (Fabian et al., 2014). High or chronic acute exposures to this chemical can cause a firefighter to develop chronic pulmonary disease.

**Carbon monoxide.** Carbon monoxide is an asphyxiant, meaning it interferes with the blood's oxygen-carrying capacity. Acute carbon monoxide poisoning may cause headaches, dizziness, drowsiness, nausea, fainting, coma, and even death (Fabian et al., 2014). Exposure to this toxin can also produce cardiac effects such as exercise-induced angina.

**Hydrogen cyanide.** Hydrogen cyanide is also an asphyxiant, affecting cellular oxygen utilization (Fabian et al., 2014). Lower levels of exposure can cause headaches, dizziness, drowsiness, nausea, and vomiting; higher exposures can cause loss of consciousness and death (Fabian et al., 2014).

**Hydrogen sulfide.** At lower concentrations, hydrogen sulfide is an irritant to eyes and the upper and lower respiratory tracts; however, it is a chemical asphyxiant at higher concentrations. The effects of this toxin are dependent on the exposure level and can range from headaches, dizziness, drowsiness, nausea, and vomiting to convulsions and death (Fabian et al., 2014).

**Nitrogen dioxide.** Nitrogen dioxide is an irritant to the eyes and upper and lower respiratory tracts. Brief exposures at high concentrations can result in a rapid onset of cough and shortness of breath (Fabian et al., 2014). Some individuals exposed to this toxin may develop pulmonary disease.

**Sulfur dioxide.** This toxin causes severe irritation to the skin, eyes, and nasal and oral mucous membranes. At high concentrations, sulfur dioxide may lead to lower respiratory tract complications such as cough, shortness of breath, and bronchospasms (Fabian et al., 2014).

**Polycyclic aromatic hydrocarbon.** The most-studied chemical among researchers, polycyclic aromatic hydrocarbon is carcinogenic in several tissues, such as skin, mammary glands, and the respiratory system (Fabian et al., 2014). This chemical can enter the body through inhalation or absorption.

**Phthalate esters.** Phthalate esters, irritants to eyes and mucous membranes, are a class of chemicals used principally as plasticizers (Fabian et al., 2014). The chemical also has an EPA classification as B2, which means it is probable to cause cancer among humans (Fabian et al., 2014).

Given everything known regarding toxins commonly present at structure fire sites, there is a growing concern among the firefighting community to limit these types of exposures (Easter et al., 2016). All chemical toxins discussed have immediate health impacts on firefighters at low exposures, and some have more detrimental consequences at high concentrations. Depending on the firefighters' tasks at the fire scene, exposure can range from low to high. Compliance in wearing PPE will also have an impact on the level of exposure. Lack of compliance in wearing PPE, such as respiratory protection, continues to be a problem within the profession, something explored later in this literature review.

Studies have shown chemicals and particulates can accumulate in firefighters' protective clothing over time (Easter et al., 2016; Lacey et al., 2014; Maglio et al., 2016; Moore et al., 2018). Deposits on the protective gear provide paths for transdermal absorption of these chemicals (Lacey et al., 2014). Researchers examining this claim have determined that detectable levels of contaminants on firefighters' skin post-fire may lead to skin absorption as a route of exposure (Baxter et al., 2014). Fire smoke consists of a complex mixture of substances that varies based on what is burning, the temperature during combustion, and the ventilation conditions during the emergency response (Fent et al., 2018). As a result of these studies, professional recommendations are decontaminating firefighter gear post-structure fire response and having firefighters shower promptly after responses (Kirk & Logan, 2015).

These types of acute exposures open firefighters to the risk of developing different types of cancer (Moore et al., 2018). Colon cancer in particular is linked to occupational exposures (Sritharan et al., 2017). In addition, chronic exposures accompanied by increased heart rates expose firefighters to the development of cardiovascular diseases (Banes, 2014). The problem is not unique to the United States; researchers in other countries have seen similar results when examining occupational exposures of firefighters (Ahn & Jeong, 2015). During the emergency response, firefighters tend to focus primarily on the immediate situation and disregard the health hazards associated with the emergency (Maglio et al., 2016). This lack of hazard awareness contributes to increased risk-taking behavior during emergency responses, with consequences that may not appear until years later.

In addition to exposures to health hazards associated with emergency responses, firefighters routinely encounter traumatic events throughout their careers (Lee, Dayoung, Jiae, Kyoungsun, & Minyoung, 2017). Exposures to traumatic stressors can have negative outcomes

through the development of posttraumatic stress disorder (PTSD) among firefighters (Sommerfeld, Wagner, Harder, & Schmidt, 2017; Young, Partington, Wetherell, St Clair Gibson, & Partington, 2014). In previous studies, researchers have shown that exposure to direct and indirect traumatic events creates an increased risk of developing PTSD (Garner, Baker, & Hagelgans, 2016; Gulliver et al., 2016). In addition, repeated exposure to traumatic events increases the risk of developing secondary trauma conditions, such as vicarious traumatization or compassion fatigue (Lee et al., 2017). Secondary traumatic stress deteriorates physical and mental functioning, impairments that could have a significant impact on perceptions in hazardous situations during emergency responses (Lee et al., 2017).

Firefighters work in a high-risk environment compared to the general population (Prati et al., 2013). The occupation of a firefighter consists of unpredictability, high risk, and danger (Smith et al., 2016). When firefighters are carrying out their duties, the stakes are high and making decisions must be quick. Scholars agree that time also plays an important role in risky behavior (Prochniak, 2014). Firefighters during dangerous occupational tasks have a perception of lack of time pressure (Prochniak, 2014). In addition, firefighters have demonstrated that when a life is in danger, their individual risks increase (Maglio et al., 2016). The risks taken by firefighters in their work are deeply rooted in their personal nature and the culture of the profession, shaped by internal and societal expectations of firefighters (Maglio et al., 2016).

Firefighters' goals include helping, goodwill, safety, and social order (Prochniak, 2014). According to Fender (2003), firefighter motivation falls into one of three components: achievement, affiliation, and power. Researchers have confirmed these motivators based on firefighters' need to find their place within the profession and fulfill an image, as well as the tendency to become consumed in goal completion in emergency settings (Maglio et al., 2016).

To achieve these goals, firefighters often take risks, the consequences of which may be immediate or delayed (Prochniak, 2014). The belief among firefighters is that they must accept the risks that come with the occupation and, in some cases, that their actions may result in injury or death (Scarborough, 2017). Based on this belief, firefighters take certain risks that can potentially put them and their colleagues in danger (Rodríguez-Garzón et al., 2016). Firefighters have demonstrated that they are aware of the dangers of occupational exposures in their profession but believe that this is part of the job (Anderson et al., 2017). When firefighters discuss these risks and their association with causing cancer, there is a degree of fatalism, meaning they believe such risks are outside of their control (Anderson et al., 2017).

In a recent study on PPE used in hazardous situations, Maglio et al. (2016) found that even with a high level of demonstrated safety knowledge, compliance among firefighters was low. The majority of the research into occupational exposures firefighters face in the course of carrying out their duties has shown the use of PPE minimizes exposure risk; however, even in overhaul operations, respiratory compliance is inconsistent (Gainey et al., 2018). Informing firefighters of the risks of dermal exposure may increase the compliance of PPE cleaning procedures and decrease the number of exposure risks faced (Easter et al., 2016). However, Harrison et al. (2017) found that dirty gear represented a badge of honor and signified experience among members of the fire service. As such, it is apparent that education alone does not have a significant effect on changes in safety perception and influences on personal protection measures. There is a need for further research of the variables that affect the development of safety perception and safety behavior decisions.

## Perceptions Regarding Risk

Risk perceptions are complex yet important (Micic, 2016). Perceptions hold significant insight into predicting individuals' behavior, with risk perception associated with injury and safety behavior (Prati et al., 2013). Risk perception is the internal analysis of the probability of negative consequences when evaluating potential hazards, which leads to making a decision (Joseph & Reddy, 2013). Research has indicated that experience and familiarity are important components in developing accurate situational awareness and risk perception (Donahue, Eckel, & Wilson, 2014). Individual experiences with specific hazards and personal concern for consequences correlate with risk-based decision-making (Hahm et al., 2016).

Risk is the possibility of loss or injury (Martin, Ellis, & Delpesh, 2016). Individuals' risk perception develops from a combination of their feelings and the belief that a disease or hazard is a threat to their health (Ferrer et al., 2018). Individual perceptions of direct benefits also influence risk acceptance (Slovic, 2012). Risk perception stems from individuals' subjective awareness of potential harm from a hazard and their internal analysis of available risk information (Martin et al., 2016). Previous experience with a hazard may elevate perceived risk in individuals and has the potential to influence perceptions of other hazards (Knuth, Kehl, Hulse, & Schmidt, 2014).

In the field of emergency management, scholars have applied risk perception to the decision-making of civilians in disaster preparation and actions to evacuate (Donahue et al., 2014). An individual's underlying preferences and perceptions determine the level of preparation taken in personal protection (Donahue et al., 2014). For emergency management officials, achieving behavioral changes in populations to prepare for a disaster and act when prompted to evacuate can be a challenge. Before taking action, individuals must be knowledgeable about risk

and believe they are at risk of physical harm. Knowledge comes from experiences and education, individuals' ability to understand risk, and their response to risk influence risk perception (Martin et al., 2016). A population's vulnerability increases when individuals are not aware of the hazards that pose a threat. Research has also shown that economic and education levels have an impact on risk perceptions (Hicks & Brown, 2013). Insight into how individuals and populations develop their risk perceptions can contribute to local emergency management officials better understanding how to initiate behavioral change and knowing the appropriate medium to use (Martin et al., 2016).

In an emergency, risk perception influences health behavior and protective action (Hahm et al., 2016). Previous experience with a specific hazard may affect individuals' safety perceptions and decision-making (Donahue et al., 2014). In contrast, the lack of personal experience in combination with a sense of dread has a significant effect on the perception of risk (Micic, 2016). Perceptions about the surrounding environment during emergency response influence emergency responder decisions (Petrucci, Horn, Rosengren, & Hsiao-Wecksler, 2016). This finding is important because the misjudgment of risk often leads to greater injury (Ivensky, 2016). Research studies lend validity to the importance of perceptions in influencing safety behavior. Further research in the area of risk perception can inform future inquiry in the field of emergency management.

Knowledge of a specific hazard to one's life has a significant effect on risk perception (Martin et al., 2016). Perceptions stem from an individual's familiarity with the hazard; therefore, poor risk perceptions can contribute to erroneous decision-making (Joseph & Reddy, 2013). An example is firefighters choosing not to wear respiratory equipment when they are outside the burning structure, even though studies have shown the risks of exposures

immediately outside non–fire-suppression activities, such as ventilation or outside command (Fent et al., 2018). Knowledge of risks has an impact on individuals’ risk perception and safety behavior, as evidenced by the slow changes in SCBA use among firefighters during responses where they might encounter IDHL environments (Anderson et al., 2017). Accordingly, the lack of proper education on risk can threaten firefighters’ livelihood, such as when responding to brush fires without any respiratory protection (Anderson et al., 2017).

In a field in which wrong decisions have fatal consequences, ensuring that firefighters have accurate risk perception is essential in protecting these workers (Rodríguez-Garzón et al., 2016). The development of risk perception is complex, influenced by many variables depending on an individual’s beliefs, experiences, and desired outcomes. External factors such as job, social, and individual expectations and peer pressure can have both positive and negative influences on an individual’s perceptions of hazards (Maglio et al., 2016). Gaining insight into emergency responder perceptions may inspire those in the field of emergency management to analyze influences on risk perceptions and decision-making to better inform safety program development (Smith et al., 2016). Understanding these influences on safety behavior could lead to the development of programs to initiate behavioral change, which can improve the safety culture to reduce occupational injuries and exposures in emergency responses (Maglio et al., 2016).

### **Influence of Safety Culture**

Safety culture is the attitudes, beliefs, perceptions, and values employees share about safety within an organization (Saujani, 2016). The definition of a positive safety culture is an environment in which organizational personnel indicate that safety is the priority of the entire group through their daily actions (Lundell & Marcham, 2018). Negative safety culture can be

difficult to modify, especially in the slow-changing U.S. fire service. An example of this slow change is certain field symbols associated with experience and toughness, such as having dirty helmets and turnout gear (Anderson et al., 2017). Despite signs of firefighters taking preventative measures against cancer, there is a concern that these changes are not occurring fast enough (Anderson et al., 2017). Following are descriptions of key elements to positively affect a safety culture change within an organization.

Firefighting is an occupation with high physical demands and hazards; injuries within the fire service are a regular concern for department leaders (Poplin et al., 2015). Managers can positively affect the safety culture if they understand the various leadership approaches to manage the culture (Lundell & Marcham, 2018). An effective safety program positively influences the safety culture if it involves the elements of management commitment, employee ownership, system data, system integration, and organization-wide engagement (Saujani, 2016). In addition, if organizations wish to improve the overall safety culture, leaders must understand that people are social learners, safety culture is a social structure, and culture change will take time and effort (O'Kelley, 2019).

Organizations must provide observational training to improve safety culture; written policies and procedures are not enough, as employees learn positive safety behaviors through actual practice (O'Kelley, 2019). Developing a positive safety culture involves modeling employees who embody the desired culture, especially when training new workers (O'Kelley, 2019). Leaders must consider rewarding positive safety behavior; it does not matter what the reward is as long as it is immediate and consistent (O'Kelley, 2019). An organization must acknowledge that employees are capable of doing a job the right way or the wrong way, necessarily praising positive safety behavior to promote continued behavior (O'Kelley, 2019).

Failures with leadership approaches to safety can negatively affect organizational safety culture (Lundell & Marcham, 2018). Leaders who are unwilling or unable to address or reveal their own limitations adversely impact safety cultures (Pater, 2018). Accordingly, leaders must acknowledge the biases that can cause them to overlook, ignore, or minimize potential contributing factors that lead to safety incidents (Pater, 2018). Leaders must also do more than announce expectations; they cannot expect employee buy-in just because they have ordered it (Pater, 2018). Misjudging or displaying the wrong type of leadership approach at the wrong time can degrade a good safety culture and halt the progress of positive culture change (Lundell & Marcham, 2018).

Firefighters are more likely to take part in safety programs when asked to participate in program development (Poplin et al., 2015). Changing the culture within the fire service requires support and reinforcement from supervisors (Lundell & Marcham, 2018). A top-down approach provides a focus on understanding and changing the fundamental values and beliefs of the organization through policies and guidance (Lundell & Marcham, 2018). A culture of leader-modeled safety and accountability on a peer-to-peer level creates an environment that promotes safety practices within an organization (Lundell & Marcham, 2018). In an examination of the influences on decisions of personal protection during emergency responses, the safety culture of the organization must come into consideration.

### **Heroism and Altruism**

Modern society has expectations of heroism and of individuals who hold duty-bound positions, such as firefighters. Researchers could inform the study of external and internal expectations that may influence firefighters' perceptions of hazards, and whether these individuals accept risks based on their occupations and societal expectations. Current research

shows individuals are willing to tolerate risks if they believe it will improve the well-being of others (Zinn, 2015). Heroes are those who, at great personal risk, choose to act for the benefit of one or more others, despite the possibility of suffering serious consequences, including death (Franco et al., 2016). The definition of heroism is largely shaped by cultural and historical contexts (Keczer, File, Orosz, & Zimbardo, 2016). Society holds an image of firefighters as risk-takers, with a romanticized notion that firefighters do what needs to be done to save lives, even if it ends in their own deaths (Maglio et al., 2016). The combination of both cultural and societal expectations leads most firefighters to take great risks to save lives during emergency responses (Scarborough, 2017).

These expectations are also associated with the stereotypical images of bravery and heroism traditionally associated with men (O'Neill & Rothbard, 2017). The implication is not that only men show bravery; however, there is a societal expectation for males to display strong traits of bravery, especially in male-dominated fields such as emergency response. Indeed, firefighting is a male-dominated field within the United States (Phelps et al., 2017). According to the 2000 U.S. Census, only 3.7 % of career firefighters were women (Perrott & Blenkarn, 2015). Thus, males' focus on fulfilling the stereotype of bravery and heroism has had a negative influence on risk-taking during emergency responses (Maglio et al., 2016). Attempting to uphold the image of the strong, macho firefighter and its impact on safety behavior needs further investigation.

There are many examples of heroes, including professional heroes who act due to a sense of duty (e.g., military personnel, emergency responders), as well as individuals consistently involved in social issues and referred to as lifelong or situational heroes (e.g., brave civilians; Keczer et al., 2016). Regardless, society views heroes as a shield, defending the vulnerable from

harm in the face of serious physical risk. Firefighters fall under the socially defined category of transparent heroes, along with other emergency responders, teachers, and nurses (Keczer et al., 2016). Transparent heroes are those who carry out their duties often unnoticed, largely because society's expectations of heroic acts are associated with their job duties. Firefighters qualify as transparent heroes, as there is a societal and individual expectation to perform heroic acts as part of the job (Maglio et al., 2016).

Instilled in emergency responders is a societal expectation that it is their duty to act in emergency situations (Maglio et al., 2016). Beginning in their recruit academies, firefighters know they must have the courage to act, be selfless, and in some cases, make the ultimate sacrifice to save a life (Scarborough, 2017). There is a moral obligation with the occupation to carry out altruistic acts. Firefighters exemplify altruism through service to the community, at times at great physical risk. This finding is in line with Yang (2016), who noted that individuals who perceive a higher level of personal desire to be noticeable or important demonstrate altruistic behaviors in risky contexts.

Altruism plays an important role in individuals' decisions to take risks, with the desire to make a difference as the primary motivator (Zinn, 2015). Altruism is when individuals act in a way that benefits another (Lemieux, 2014). Altruism is an individual motivation from the desire to improve the welfare of others without expectation of reward (Lemieux, 2014). Firefighters exemplify altruistic behavior in carrying out their duties. Major emergencies have an impact on human behavior, increasing the level of altruism observed among people (Oishi et al., 2017). Furthermore, in the wake of disasters, there is a spontaneous notion of community and coming together for a cause (Oishi et al., 2017). This concern for others at the expense of self could also

affect the development of risk perception and safety behavior when firefighters respond to events where others are in need.

Researchers have found another influence of unsafe behavior to be goal seduction (Maglio et al., 2016), or individuals' desire to prioritize meeting goals over their own safety. Goal seduction negatively leads firefighters to take risks in hazardous situations (Bearman & Bremner, 2013). One example of goal seduction is violating driving laws to arrive at the emergency scene quickly; another is not waiting for additional resources to arrive before attempting a rescue based on the perception that there is no time and lives are at stake.

### **September 11, 2001, and Resulting Health Hazards**

Goal seduction is visible through analysis of the events that took place on September 11, 2001 (9/11), when terrorists hijacked two airplanes and crashed them into the Twin Towers of the World Trade Center. New York City firefighters and police officers ran into danger and the near-certainty of death to save as many lives as they could. The attacks killed 2,749 people, 439 of whom were emergency responders (Mendonça, Webb, Butts, & Brooks, 2014). The buildings' collapse released dense dust clouds of particles that settled on the streets and within buildings throughout Lower Manhattan (Lippmann, Cohen, & Chen, 2015). Emergency responders spent many of the following days searching for survivors and carrying out rescue operations, acts that released dust deposits back into the air (Lippmann et al., 2015). Exposures from the aftermath of 9/11 were unusually high due to the intensity and complexity of substance mixtures faced by rescue workers during their response (Solan et al., 2013). Taking this undefined risk is another example of the duty-bound expectation to act, as rescue workers placed themselves in extreme environmental hazards to search for survivors. Reports of the health effects of such exposures began within 48 hours of the attack (Gilbert & Ponder, 2014).

Approximately 90% of rescue workers involved with the 9/11 post-disaster response developed respiratory issues, beginning with an acute cough that progressed over the following months (Gilbert & Ponder, 2014). Such exposure became a serious medical concern, with the medical community soon identifying the respiratory ailments as the “World Trade Center cough” (Gilbert & Ponder, 2014). Rescue workers made choices during that response, the outcomes of which may not have emerged until later. Doctors soon found a strong causal link between direct exposures on site to the development of certain cancers among rescue workers (Solan et al., 2013). Many of the known products of combustion present at the sites of the 9/11 attacks are also at structure fires (Edelman et al., 2003). Although it is not possible to generalize exposures to chronic diseases, the examples of 9/11 first responders correspond with the health effects on firefighters from emergency response exposures.

Emergency responders find themselves caught between conflicting expectations, bound by duty and societal expectations (Maglio et al., 2016). This incompatibility is evidence of the stereotype that firefighters and other first responders are risk-takers, and that by accepting the position, they have agreed to die if needed to save others (Maglio et al., 2016). These expectations, both internal and external, influence the personal beliefs of an emergency responder and may have an impact on decision-making (Maglio et al., 2016). In the case of 9/11, emergency responders prioritized the lives of others over their own by entering a hazardous situation, understanding the outcome could very likely be their demise (Rodríguez-Garzón et al., 2016).

Society’s definition of a hero and its expectations of heroism in specific occupations indicates to individuals in these roles that they must put others before themselves (Maglio et al., 2016). Such expectations can influence individuals’ decisions on placing themselves in

hazardous situations to help those in danger, acting on instinct over self-preservation. Individuals who have researched acts of heroism with either immediate or long-term health consequences can inform the research community as to what shapes emergency responders' safety perceptions and behaviors.

In this research study, the goal was to identify what factors influence decisions on safety behavior. Because past research has shown individuals are more likely to take risks if they perceive that risk will benefit others (Zinn, 2015), there is a need for further study to discover how the expectations of duty-bound heroism affect decisions made regarding personal protection during emergency responses. Gaining insight into the various factors that influence firefighters' decisions on personal protection during emergency responses will further inform the field of emergency management and assist with the development of injury prevention programs for emergency responder occupations.

### **Health Belief Model**

The health belief model is a means to predict health behaviors and to explain why individuals choose not to participate in health programs (Linke et al., 2014). This theory emerged in the 1950s to provide understanding and explanation of individuals' decisions regarding participation in preventative health services. The need for such explanations came from a lack of participation in free health programs within at-risk communities. According to the health belief model, individuals' perceptions of variables—such as the severity of the risk prevented by the program, their susceptibility to the illness, the benefits of engaging in the behavior, and the barriers they face in engaging in the behavior—determine their likelihood of participating in a health behavior program (Linke et al., 2014). In line with the health belief model, motivating individuals to act requires them to believe the potential illness is a serious risk to them, that they

are highly susceptible to the illness, and that their benefits of engaging in a health behavior supersede the barriers they must overcome (Linke et al., 2014). The health belief model also indicates that to provoke an individual to participate in a health behavior change, there must be a cue to action, without which individuals are less likely to change their health behaviors. This cue could be media campaigns about health issues and physical reminders.

Researchers have used the health behavior model to explain the adoption of single preventative behaviors using such actions as vaccinations and screening, healthy lifestyle adoption, illness prevention, and sick-role behavior (Bishop et al., 2015). The health belief model would be an appropriate theory for measuring individual perceptions in response to a health threat impact likely to motivate action. Utilizing this theory, Bishop et al. (2015) investigated individuals' perceptions regarding the severity of the harm possible from performing or not performing an action as influenced by their overall perception of threat. Perceptions play a key role in the health behavior model as in rational choice theory; however, the former is concerned with understanding key factors that influence individuals' actions. In addition, the health belief model is a theory used in an attempt to understand and predict health-related behavior. The majority of applications of the health belief model are in the field of health and wellness.

Although the majority of recent health belief model applications have been on behaviors related to participating in preventative health programs, some scholars have explored injury-related behavior (Zhang et al., 2013). This theory is applicable to research as a means to explain injury-related behavior. Individuals could use a new understanding of injury-related behavior in developing injury prevention strategies (Zhang et al., 2013). In an injury-related behavior study, the researcher applies the dimensions of the health belief model by conducting an assessment of the subject's perceived susceptibility to the hazard, the perceived severity of exposure to that

hazard, benefits from participating in the proposed program and barriers to participation, and the cues to action (Bishop et al., 2015). In a study of the injury-related risk behaviors of students utilizing the health belief model, Zhang et al. (2013) found the need to incorporate psychological intervention, which focuses on the study of self-efficacy, or individuals' belief in their ability to execute the behaviors necessary to achieve desired outcomes (Zhang et al., 2013).

### **Theory of Reasoned Action**

The theory of reasoned action is also a means to explain individuals' voluntary behavior. Researchers frequently use the theory of reasoned action to predict individual health-related behaviors in health education studies (Tavousi et al., 2015). According to the theory of reasoned action, individuals' likelihood to engage in a specific health behavior stems from the strength of their intent to participate in that behavior (Linke et al., 2014). Intentions are a combination of the individual's subjective norms and personal attitudes toward the specific behavior. The way individuals perceive the consequences of conducting a specific health behavior and the importance they place on the consequences develop their attitudes (Linke et al., 2014). In addition, individuals are motivated to comply with a specific behavior based on others' beliefs about that behavior. For example, if a teenager's friends strongly believe that smoking leads to serious medical issues, the teen is less likely to smoke. In line with this theory, therefore, individuals' intentions have a direct influence on the effort they will take to perform the behavior, which increases the likelihood of the behavior.

Another recent study incorporated the reasoned action approach theory, which stemmed from the theory of reasoned action, because reasoned action explains that the influence of various components allows researchers to predict individual intentions and action. Actions may vary among different populations and behaviors (Conner, McEachan, Lawton, & Gardner, 2017).

Because of this, researchers have updated the theory of reasoned action to include more spontaneous channels to action that might be particularly relevant to risk behaviors. The reasoned action approach is appropriate for quantitative research to test hypotheses by determining how the subcomponent pairs of attitudes, perceived norms, and perceived behavioral control predict individuals' intentions and actions (Conner et al., 2017).

The theory of reasoned action implies that individuals' behavior is motivated by their intention to perform a behavior (Jackson, 2012). Identifying intentions begins with an assessment of an individual's attitudes and subjective norms (Tavousi et al., 2015). The theory of reasoned action provides a structure for connecting each of the variables discussed; however, it is not without its critics. One of the prominent limitations is that this theory is more effective in circumstances that are under an individual's voluntary control, but less so when the individual cannot control the behavior (Tavousi et al., 2015). For this reason, although the theory of reasoned action may partly explain firefighters' decisions to use PPE, rational choice theory provided a better framework for this study.

### **Rational Choice Theory**

Rational choice theory shows individuals make the best decision based on the specific circumstances (Burns & Roszkowska, 2017). When faced with a decision-making situation, individuals consider all available alternatives, the consequences of those decisions, and the importance and value of those choices in deciding on the best outcome (Burns & Roszkowska, 2017). Rational choice is a means to explain people's actions, given their conscious mental state (Hampsher-Monk & Hindmoor, 2010). The purpose of this theory is to describe how actions of an individual arise from deliberate or intentional pursuits of self-interest (Lovett, 2006). Rational choice is an action a person takes based on the belief it is the best action available based on time

constraints, personal beliefs, and desired outcomes (Dietrich & List, 2013; Hampsher-Monk & Hindmoor, 2010). Placing oneself in dangerous situations is not a rational action for the general population; for firefighters, however, there is an expectation to respond to emergencies without hesitation (Maglio et al., 2016; Scarborough, 2017). Delayed action in emergencies can result in injury or death. Rational choice theory literature explains that individuals can act outside of their self-interest, behaving in an altruistic manner (Lemieux, 2014; Zinn, 2015). Paternoster et al. (2017) discussed how feelings such as sympathy, altruism, and fairness influence decision-making. The perceived benefits of others may influence individuals' choices rather than a self-focus (Paternoster et al., 2017).

Social science researchers use rational choice theory as one of many tools to explain social phenomena (Lovett, 2006). To this end, rational choice theory explains social phenomena by demonstrating that decisions stem from the pursuits of self-interest, whether deliberate or unintentional (Lovett, 2006). Rational choice theory consists of two axes, the decision axis and the command axis, meaning that decisions made on a rational basis lead to the decision on whether to act (Khalil, 2017). Another factor that influences decisions is individual norms—namely, if people make a decision not to engage in deviant behavior, it is because of their personal morals (Li, Luo, Zhang, & Sarathy, 2018). The internal cost-versus-benefit analysis individuals conduct based on rational choice theory is the same among firefighters making risk decisions on the fireground (Scarborough, 2017).

Scholars have applied rational choice theory to criminology to understand what motivates individuals to commit crimes (Akers, 1990). In criminology discourse, researchers have utilized rational choice theory to explain that individuals' motives of self-interest lead to committing crime as the easiest method to securing what they want (Paternoster et al., 2017)—in other

words, they perform a cost-benefit assessment (Li et al., 2018). Applications of rational choice theory have helped to explain deviant behaviors such as theft, driving impaired, and corporate crime (Li et al., 2018).

The theory also applies to economic decision-making. For instance, if people are aware of the costs and benefits of their choices, they will choose the option that provides maximum value. There is an opportunity to expand on this theory in an emergency management field. Firefighters determine how much they are willing to risk based on the saying, “Risk a lot to save a lot, risk little to save little” (Scarborough, 2017, p. 1073). Firefighters share a common value in that their number one priority is saving lives, which may influence their internal cost-versus-benefit analysis.

Further scholarly inquiry is needed to determine what firefighters consider rational behavior. When such personnel respond to an emergency scene, identifying the cost-versus-benefit analysis that occurs internally to influence decisions is of significant importance. Determining what other variables influence decision-making processes may provide insight into firefighters’ rational choices regarding the use of PPE.

### **Synthesis of the Research Findings**

The occupation of a firefighter is dangerous and complex because firefighters frequently respond to hazardous situations that are high risk (Young et al., 2014). The role of a firefighter is different than most occupations, as firefighters directly enter hazardous environments, whereas other people avoid hazards (Smith et al., 2016). In addition to these exposures, firefighters spend time within the structure in a post-fire environment where they face the aftermath of combustion, which also poses significant health risks (Easter et al., 2016). There is a considerable amount of research on the relationship between firefighter exposures and cancer (Harrison et al., 2017;

Jahnke et al., 2012), as previous scholars have found firefighters exposed to harmful toxins through many phases of the emergency response (Maglio et al., 2016). The International Agency for Research on Cancer classified firefighters' occupational exposures as possibly carcinogenic (Gainey et al., 2018).

Even with this increased knowledge of health hazards, compliance with PPE use still lags within the profession (Maglio et al., 2016). During the emergency phase, initial safety perceptions of environmental health hazards come from the observation of heavy smoke, but in post-fire situations in which firefighters work inside the structure, compliance is not consistent (Gainey et al., 2018). This inconsistency may be due to firefighters' misunderstanding of health hazards that are not visible or not detectable by gas monitoring equipment carried by fire crews (Maglio et al., 2016). Even with the knowledge of exposure risks, firefighters continue to be PPE noncompliant, which is an area in need of further research.

Risk perceptions stem from individuals' priorities. Firefighters work according to the creed, "Risk a lot to save a lot, risk little to save little" (Scarborough, 2017, p. 1073). These priorities are instilled in firefighters from the beginning of their careers, as they learn to put saving lives first and scene stabilization and property conservation last (Scarborough, 2017). The common theme is that firefighters' number one priority is the preservation of life (Scarborough, 2017). The culture of the U.S. fire service has been that firefighters are resilient in the face of danger (Harrison et al., 2017), making it difficult to implement change within the profession (Cheskin et al., 2014). Firefighters also spend considerable time in a group setting, which is notable because research has shown group culture shapes an individual's beliefs and behaviors (Scarborough, 2017). Social identity and the safety climate may predict an individual's safety outcomes (e.g., safety compliance, near misses, injuries, fatalities; Maglio et al., 2016).

Safety perceptions emerge from a combination of personal beliefs, experiences, and education (Ivensky, 2016). Both internal and external variables influence risk perceptions (Hicks & Brown, 2013). Other influences on risk perception may be organizational pressures and safety cultures (Joseph & Reddy, 2013). In addition, there is a common expectation of firefighters to accept risks that can result in their demise (Rodríguez-Garzón et al., 2016). Thus, risk perceptions are complex, with various influences in need of further investigation (Micic, 2016).

Risk perceptions have been associated with injury and safety behavior (Prati et al., 2013). If individuals perceive risk correctly, they can better prepare themselves to make appropriate decisions (Donahue et al., 2014). Development of correct safety perceptions is important because firefighters often draw upon their experience and perception of the immediate environment in making decisions (Rodríguez-Garzón et al., 2016), thus maintaining a sense of control over their situations (Hahm et al., 2016). Higher exposure to risk without experiencing negative consequences desensitizes individuals and lowers their risk perception (Prati et al., 2013). An internal analysis occurs within individuals of the risks versus benefits that influence decisions based on the reward outcomes (Fischhoff, 2015). Individuals may justify high risks if the reward is high and they cannot reduce the risks (Fischhoff, 2015).

There is a gap in the literature in understanding on how firefighters perceive environmental health hazards during emergency response situations, and how those perceptions influence decisions regarding personal protection (Rodríguez-Garzón et al., 2016). Personal protection includes not only PPE, but the decision to place themselves in a hazardous environment, as well. In addition, there is a gap in the application of rational choice theory in the emergency management field. Individuals in the field of emergency management may gain insight from the findings of this study to better understand the variables that influence emergency

responder perceptions during emergency responses and how those perceptions influence safety behavior decisions.

Rational choice theory describes the decision of the best available action based on the individual's time constraints, personal beliefs, and desired outcomes (Hampsher-Monk & Hindmoor, 2010). The application of rational choice theory will inform the field of emergency management in the development of training and safety programs aimed at targeting internal and external factors that influence firefighters' decision-making. To effectively develop and implement injury-reduction interventions, program development must begin with a thorough understanding of the factors that influence making decisions (Hong, Phelps, Feld, & Vogel, 2012). Rational choice theory application in this study provided an understanding of what internal and external elements contribute to an emergency responder's hazard perceptions during an emergency response.

### **Critique of Previous Research Methods**

There is a gap in understanding the perspectives of firefighters to environmental health hazards experienced during the emergency response, and how these perceptions influence decisions on personal protection (Rodríguez-Garzón et al., 2016). Among other organizations and researchers, Fabian et al. (2014) focused on occupational exposures to firefighters and toxicology in structure fires. In a study of firefighters' perspectives about health concerns inherent in their occupation, Jahnke et al. (2012) surveyed topics such as cardiac health, physiologic strain, and occupational injuries. Primary means of data collection were focus groups and informal interviews with key informants: the fire chief, assistant chiefs, wellness coordinators, and medical directors (Jahnke et al., 2012). However, the researchers did not interview individuals on the front lines, such as firefighters.

Data collection methods vary across the research literature. Rodríguez-Garzón et al. (2016) utilized self-administered questionnaires that participants completed in the presence of the researcher. Prochniak (2014) also used questionnaires as a means of data collection. In a study focused on firefighters' perceptions of their risk of cancer, Anderson et al. (2017) used direct observations and focus group interviews to inform the research. Gainey et al. (2018) adopted a unique approach, setting up test structure fire scenarios and observing a team of 12 firefighters conduct fire suppression and rescue operations, thus viewing real-time tactics. Scarborough (2017) conducted one-on-one interviews with 30 participants. The researcher had more success with in-person interviews, which allowed for encouraging respondents to provide deeper explanations of their experiences outside of a predetermined list of responses (Scarborough, 2017).

Each of the aforementioned studies had methodological strengths and weaknesses. With the use of focus groups, scholars were able to collect answers from a greater number of participants. A drawback of utilizing focus groups, however, is the possibility of limiting participation based on the moderator's role and the group itself. Focus groups may create concerns with reliability, validity, and generalizability (George, 2013). In addition, focus groups suffer from the dangers of relying on self-reported data and participants who may self-censure, underreport, or overreport in light of having others around. In a group setting, participants may also be concerned about privacy, which may further limit their contributions, as could having one or more outspoken individuals who dominate the conversation. Therefore, these compounded tendencies may constrain data collection efforts (Morgan, 2016). Specific to the subject of first responders, Maglio et al. (2016) found rookie firefighters less likely to vocalize their opinions in the presence of senior firefighters.

Individual interviews proved to be the most effective means to address perceptions and safety behavior. Maglio et al. (2016) found participants in one-on-interviews were more likely to express their opinions and concerns. One-on-one interviews inspire respondents to share their personal experiences, with the ability to expand on specific responses and perceptions. The use of open-ended questions enables a more natural flow, allowing interviewers to explore concepts and probe further, as needed (Scarborough, 2017). Strong individual interviews are those allowing participants to begin with standard dialogue, and then engage in deeper conversations through researcher follow-up questions, something not possible with other methods of data collection.

### **Summary**

The literature review enabled the analysis of recent findings on the topics of occupational hazards for firefighters, firefighter cancer, safety perceptions, decision-making influences, altruism, heroism, and rational choice theory. A synthesis of rich information on these subjects enabled the identification of what is known and where the gaps in understanding are related to how these topics influence a firefighter's safety perception. A critique of previous research studies followed a synthesis of findings, specifically with regard to how past scholarship influenced the design of this study. The job duties of firefighters include some of the most hazardous operations among occupations within the United States (Smith et al., 2016), with risks that can have both immediate and long-term consequences. Researchers have found a link between occupational toxic exposures and firefighter cancers (Sritharan et al., 2017). An NFPA survey showed 68,085 annual on-duty injuries among U.S. firefighters (Phelps et al., 2017), and the U.S. Fire Administration reports an average of 100 on-duty firefighter deaths annually (American Society of Safety Engineers, 2015; Ruan & Groves, 2013).

Injury-reduction intervention programs are most effective when there is a clear understanding of the factors that influence individuals' decisions (Hong et al., 2012). Scholars have identified an association between an individual's perceptions and injury and safety behavior (Prati et al., 2013). In addition, during emergency responses, firefighters prioritize the need to rescue others over their own safety (Maglio et al., 2016). Understanding the safety perceptions of firefighters and how their desires and beliefs influence safety decisions during emergency responses will further inform safety program development.

## CHAPTER 3. METHODOLOGY

### Purpose of the Study

The occupation of a firefighter is dangerous compared to the general workforce (Smith et al., 2016), with death and injury rates higher within the field than in other occupations (Poplin et al., 2015). Aside from the immediate risks of injury and death, there is the risk of occupational exposures that may cause cancer (Davis, Tao, Bernacki, Alfriend, & Delowery, 2013; Jahnke et al., 2012; McClure et al., 2019). The purpose of this study was to explore firefighters' perceptions of environmental health hazards and how these perceptions influence the use of personal protection. Despite a significant amount of literature on exposures encountered by firefighters during emergency responses, there is a gap concerning firefighter perceptions and how those perceptions influence personal protection decisions.

### Research Question

The following research questions guided the study:

**RQ1.** What are emergency responders' perceptions of environmental health hazards in emergency responses?

**RQ2.** How do risk perceptions influence emergency responders' decisions in the use of personal protection in emergency responses?

### Research Design

This study utilized a qualitative methodology with a generic design. Qualitative methodology is appropriate when the goal is to gain a particular group's insight and understanding while conducting specific activities (Leung, 2015). As described by Woodgate and Busolo (2015), the qualitative approach is suitable for researchers to gain insight into

firefighters' perceptions of environmental health hazards and personal protection in emergency responses. As described by Percy et al. (2015): "Generic qualitative inquiry investigates people's reports of their subjective opinions, attitudes, beliefs, or reflections on their experiences, of things in the outer world" (p. 78). This statement reflects the depth of the research on firefighters; the focus is the subjective opinions on safety perceptions as they pertain to environmental health hazards firefighters encounter, and the influence of such opinions on personal protection in emergency responses. The firefighters' opinions provided insight into how their perception of hazards develop and influence safety behavior. Identified themes address gaps in safety behavior within the emergency response field.

### **Target Population and Sample**

#### **Population**

The population for this study was firefighters in active emergency response roles working in the Pacific region of the United States. Selection of this target population enabled the collection of an abundance of experiences to answer the research questions. Recruitment was by online posts on two fire service-related organizations' message boards that had a wide representation of firefighters in the region. Additional recruitment took place through social media platforms Facebook, Twitter, and LinkedIn. Individuals shared the recruitment advertisement elsewhere on social media platforms, providing information and garnering interest among the firefighting community. Snowball sampling is a nonprobability sampling technique in which current participants recommend qualified acquaintances (Goodman, 1961). This sampling method enabled the utilization of trusted interpersonal relationships among firefighting colleagues to gain additional participants sufficient to answer the research questions. Snowball sampling is often effective in gathering study participants in research surrounding sensitive

subjects, such as errors in the participants' profession (Ajri-Khameslou, Aliyari, Pishgooie, Jafari-Golestan, & Afshar, 2018).

The aim of this study was to gain an understanding of firefighters' risk perceptions and how those perceptions influence decisions on the use of personal protection during emergency responses. Some of the choices made during emergency responses may violate safety regulations and departmental policies and may, therefore, be information firefighters would not want to divulge due to fear of discipline or termination. If there is a punishable atmosphere for mistakes in the workplace, personnel will be less forthcoming regarding violations of safety policies (Ajri-Khameslou et al., 2018). Snowball sampling was appropriate for this study due to the sensitive nature of discussion involving taking risks and potentially violating safety policies and procedures during emergency responses.

### **Sample**

The sample for this study consisted of firefighters working in active emergency response roles in the Pacific region of the United States. Emergency roles are those positions within a fire agency who hold primary duties, including the mitigation of emergency situations; examples of such roles include firefighting, emergency medical response, hazardous materials response, and incident management. Firefighters not in an active emergency response role did not meet the criteria for this study. Fire investigators and fire prevention officers were also ineligible unless they had an active emergency response role, as traditionally, these individuals are only involved in post-fire suppression activities such as fire investigations. As a precaution, firefighters suffering from PTSD could not participate in this study. This decision stemmed from Lee et al. (2017), who found that cumulative effects from repeated exposure to traumatic events can

produce severe emotional responses. Accordingly, interviews in which participants discuss past traumatic experiences could be a form of repeated exposure.

Answering the research questions required achieving a representative sample of the U.S. fire service. Both small and large agencies have the potential of providing data-rich experiences to inform the research questions. There was no limitation on career versus volunteer status or years of service as a firefighter; however, retired firefighters were not eligible for this study. The targeted sample size was 10 to 15 participants, or until data saturation occurred. Seventeen participants were sufficient to achieve data saturation.

## **Procedures**

### **Participant Selection**

Participants for this study were firefighters working in the Pacific United States. Individuals of all ranks were eligible according to the inclusion criteria, as long as they were in active emergency response roles. Sampling entailed the identification of a pool of firefighters who met participation criteria and would provide adequate responses to interview questions to inform the research.

### **Protection of Participants**

All participants signed an informed consent form before taking part in the study. The informed consent form provided participants with background information on the study and any risks associated with their participation. In signing the informed consent form, the firefighters agreed to take part in audio-recorded interview sessions. The informed consent also detailed that their participation was completely voluntary and that they could skip any questions they did not want to answer. If they decided to take part in the study, they were free to withdraw at any point.

Alphanumeric identifiers were a means to identify research participants to preserve their anonymity. Storage of all digital files and signed informed consent forms is in a locked personal office. No names appeared on the transcripts; rather, alphanumeric identifiers differentiated between participants to ensure privacy. All data from this research study will remain secure for seven years after study completion before undergoing destruction.

### **Expert Review**

Expert reviews of the interview questions took place prior to the data collection process. The expert reviewers consisted of seven fire service professionals and a doctoral scholar with experience conducting qualitative research. The fire service professionals ranged in years of experience and held positions actively involved in emergency response roles. Individually, each expert reviewed the proposed interview questions to determine if they were sufficient to solicit the data needed to inform the research questions. Feedback received from the group led to rephrasing the interview questions to provide a clearer direction to participants. All eight experts approved the revised interview questions.

### **Data Collection**

The data collection method utilized for this study was in-person, semistructured interviews. With qualitative studies conducted to gain insight into subjective opinions, semistructured interviews are more effective in the collection of data to inform the research topic (Percy et al., 2015). The use of semistructured interviews with open-ended questions is appropriate when the researcher has knowledge on the topic, as this method provides the opportunity to ask follow-up questions to expand on participant answers (Percy et al., 2015). Interviews allow researchers to broaden the knowledge of a social phenomenon (Herzog, 2018). The purpose of this study was to explore the understanding of emergency responder perceptions

of environmental health hazards and how these perceptions influence personal protection use during responses.

A successful interview requires participants to feel comfortable and secure (Herzog, 2018). Addressing topics pertaining to sensitive and private issues is more effective when done in a setting that offers a sense of intimacy and warmth (Herzog, 2018). Given the sensitive nature of the study—which could have led to discussions of safety behavior in which participants may have divulged actions that violated safety policies—it was, as suggested by Herzog (2018), best to conduct interviews away from worksites so participants could speak freely without fear of consequences. Therefore, all interviews took place in a private office at a local library. Participants did not identify themselves or specific agencies during the interviews.

Interviews took place at locations and times that were convenient to participants in various cities in the U.S. Pacific region. Before each interview began, participants received a physical copy of the informed consent form, with time to review and ask any questions they may have had regarding the interview process, audio-recording of the interviews, confidentiality, data storage, or any other concerns. Each participant reported having reviewed the informed consent form when e-mailed and having no questions. Participants signed the informed consent forms in person, with their signature confirming their agreement for audio-recording the interviews.

Scheduling interviews for 60 minutes was sufficient to provide participants with enough time to reflect on the questions and offer in-depth responses. The semistructured interviews consisted of 10 open-ended questions, as approved by the expert review panel. During interviews, the participants were free to expand upon any of their responses or to seek clarity about any of the questions. Participants were also able to refuse to answer any question about which they felt uncomfortable or preferred not to answer; however, no participants declined to

respond to any of the questions. The 10 approved questions on the interview protocol served as a guide, allowing for additional probing or follow-up questions when participants mentioned something that warranted further investigation.

A Sony digital voice recorder (PX370) provided the means to record each interview, with audio recordings saved as MP3 files and subsequently uploaded to a secure thumb drive and saved on a secure laptop. Beginning with data collection, each participant received an alphanumeric identifier to maintain individual privacy. The names and identifying information for each alphanumeric identifier also reside on a secure data storage device, with interview logs, signed informed consent forms, and other interview data in a secure private office.

### **Data Analysis**

After completion of the data collection process, the next step was interview transcription and analysis using a thematic analysis approach. Thematic analysis is a method of identifying, analyzing, organizing, describing, and reporting themes within a data set (Nowell, Norris, White, & Moules, 2017). There are three types of thematic analysis: inductive, theoretical, and thematic with constant comparison (Percy et al., 2015). Of these three types, the most effective is thematic analysis with constant comparison, in which the process begins in the early stages of data collection, with each participant's responses analyzed to code and cluster patterns (Percy et al., 2015). In thematic analysis, data comparison with each subsequent participant's responses continues throughout the process until patterns develop and themes emerge. The limitation of thematic analysis is that it is not appropriate if a researcher desires a deeper understanding of the phenomenon (Percy et al., 2015).

Thematic analysis can be time-consuming, especially as one-on-one interviews often generate large amounts of data (Sutton & Austin, 2015). The important part of data analysis is

keeping true to participants' words by managing data and providing accurate accounts of participants' perspectives (Sutton & Austin, 2015). Data analysis entailed conducting thematic analysis as a means for identifying, analyzing, organizing, describing, and reporting themes found within a data set (Nowell et al., 2017). In a generic qualitative approach with a goal of providing rich descriptions of the phenomenon under investigation, the use of thematic analysis is common (Kahlke, 2014). To begin data analysis, transcript review entailed highlighting any sentences, phrases, or paragraphs that appeared to inform the research questions, with subsequent comparison to confirm or disprove correlation. Unrelated data went into a separate document for later reevaluation. Coding of data or common experiences and reoccurring words took place in accordance with the research question to which they applied. Clustered sets connected or related to the research to develop patterns, with a subsequent synthesis of themes enabling a comprehensive description of the phenomenon (Percy et al., 2015).

The data analysis occurred in six phases, as outlined by Nowell et al. (2017): familiarizing oneself with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the reports. As cited in Nowell et al., these procedures are a means to meet the trustworthiness criteria. Achieving familiarity with the data came from conducting interviews, transcribing recordings, and then reading and rereading the transcripts, with transcripts organized for further review and reference during the data analysis process.

Following data familiarization came the generation of initial codes. Sutton & Austin (2015) explained coding as "identifying topics, issues, similarities, and differences revealed through the participants' narratives and interpreted by the researcher" (p.228)). Coding is the process of creating and assigning meaningful labels to specific segments from the data (Terry,

Hayfield, Clarke, & Braun, 2017). Analyzing interview transcripts entailed tagging significant items within the data using a few words, as described by Terry et al. (2017). Coding occurred by hand using hard copies of the transcripts, which Sutton and Austin (2015) recommended as a general process for all studies. Establishing confidence in the findings entails meeting the four criteria of trustworthiness: credibility, transferability, dependability, confirmability (Sutton & Austin, 2015). Credibility comes from having prolonged engagement with the data (Nowell et al., 2017). By providing thick description, the opportunity for transferability to other situations and samples increases (Nowell et al., 2017). Ensuring the research process was logical, traceable, and clearly documented was a means to achieve dependability (Nowell et al., 2017). Confirmability comes about when interpretations and findings are clearly derived from the data (Nowell et al., 2017).

After establishing codes, the next step was the construction of themes in accordance with a process outlined by Terry et al. (2017). Thematic construction entails sorting and collating all coded extracts from the data (Nowell et al., 2017). Developing themes involves drawing together codes from one or more transcripts to present the findings of qualitative research (Sutton & Austin, 2015). Therefore, participant interview statement similarities underwent grouping and coding.

In line with the guidelines of Nowell et al. (2017), the next step in the data analysis process was evaluating the themes to determine if they answered the research questions. Reviewing themes for validity was a way to ensure themes properly reflected the meanings evident in the entire data set (Nowell et al., 2017). Removal of any codes with insufficient data or having an overlap with other codes followed, a process that continued until there was no text left relevant to the research questions. Investing sufficient time for developing themes improved

the likelihood of credible findings (Nowell et al., 2017). Following the theme review, defining and naming themes was the next course of action necessary to complete the story told by the data collected (Terry et al., 2017).

The final step of the data analysis process was the production of the report (Nowell et al., 2017), which included an explanation of all themes. Quotes from participants for each theme served to provide thick descriptions to inform the research questions. Chapter 4 includes a discussion of the themes that emerged from data analysis, as well as detailed descriptions of those themes.

## **Instruments**

### **The Role of the Researcher**

Generic qualitative research is appropriate when the researcher has existing knowledge and understanding of the topic (Percy et al., 2015). Existing knowledge includes current employment by a fire department and 15 years of experience, as well as exposures to many environmental health hazards and experiences of colleagues injured and diagnosed with chronic illnesses from occupational exposures. These experiences provided existing insight and knowledge into the duties of an emergency responder. The use of bracketing was a means to avoid bias. Bracketing is the practice of setting aside preconceptions, theoretical commitments, and life experiences about the subject, which may be difficult when the researcher shares experience and knowledge regarding the topic (Gregory, 2019). Therefore, adherence to strict guidelines in interviews and data collection was necessary to set aside personal bias and focus only on participants' experiences. Bracketing also entailed not leading participants during interviews and only allowing participants to share their own experiences. As an additional safeguard, there were no preexisting relationships with any of the participants.

Maintaining a journal throughout the data collection and analysis process ensures the researcher's personal experiences or insights do not affect the outcomes of the interviews (Nowell et al., 2017). A subsequent review of the researcher's thoughts and feelings is another means to ensure personal bias does not influence the results. Safeguards were necessary to mitigate bias and allow for accurate data collection and analysis.

### **Researcher-Designed Guiding Interview Questions**

The data collection method utilized for this study was in-person interviews. The two types of interview questions were the demographics questions that preceded the interview, followed by the actual interview questions used to answer the research questions. Demographic questions were as follows:

1. What is your age?
2. What is your gender identification?
3. What is your marital status?
4. What is your current position within the fire department?
5. What are your current years of service?
6. What is your current education level?

Seven fire service professionals and one experienced doctoral researcher field-tested the 10 interview questions that informed the study. Each participant selected for this process had experience with the population and research study topic. The following interview questions provided sufficient data to answer the research questions:

**RQ1.** What are emergency responders' perceptions of environmental health hazards in emergency responses?

1. Describe what goes through your mind during a response.

2. Describe your risk assessment process during a response.
3. What are the environmental health hazards you experience during a response?
4. What determines the level of risk you will take during a response?
5. Describe your understanding of the long-term health issues associated with your profession.

**RQ2.** How do risk perceptions influence emergency responders' decisions in the use of personal protection in emergency responses?

1. What personal protection measures do you take during a response?
2. What determines the level of personal protection you take during a response?
3. What personal protection equipment does your agency provide for you?
4. Describe any exceptions you make for the use of personal protection equipment.
5. When do you discontinue use of personal protection equipment during a response?

### **Ethical Considerations**

There were several ethical considerations associated with this study, one being the protection of each participant's identity. Participants' names, occupations, and employers remained secure to ensure participant anonymity. Researchers must safeguard all identifying information to prevent others from knowing the identity of participants (Saunders, Kitzinger, & Kitzinger, 2014). Establishing participant anonymity protects participants and creates an environment for respondents to share sensitive information they may not have divulged to anyone else (Saunders et al., 2014). Because participants discussed issues about environmental health hazards and their use or lack of use of personal protection that may conflict with occupational safety regulations or policies, anonymity limited the risk of repercussion. Maintaining privacy also encourages participants to answer interview questions truthfully. As a

means of further protecting participants, no recruitment occurred on worksites. In addition, interviews took place at a library in a neighborhood away from the work location. Participants were not to identify themselves or a specific agency during their interviews; however, had this occurred, such information would not have appeared in the transcripts or results.

The storage of participant information is on a password-protected computer in a locked office. Assigning alphanumeric indicators to each participant was an effective means of protecting privacy. Participants' names did not appear on any recordings, transcripts, journals, or memos so that no data were traceable to individual participants. Data analysis took place in a secure home office. Destruction of all files and information will occur 7 years after the completion of the study.

Another area for consideration in participant protection was being careful not to retraumatize participants, something that may have occurred during discussions of past emergency responses in which they were injured, or a colleague was injured or killed. Had this occurred, the interview would have stopped, and participants would have been provided information on counseling services. To minimize this risk, individuals who suffered from PTSD were ineligible to participate, a decision made because the cumulative effects of repeated exposure to traumatic events can produce severe emotional responses days, months, or years later (Lee et al., 2017). Participants confirmed they did not have PTSD prior to scheduling an interview. In addition, the interview would have terminated had participants demonstrated any signs of PTSD during the interview. None of the participants experienced negative reactions to the interview questions.

## Summary

This study focused on gaining insight into firefighters' perceptions of environmental health hazards experienced during emergency responses and how these perceptions influenced decisions on personal protection. The population and sample included firefighters working in the U.S. Pacific region currently assigned to emergency response roles. This was a qualitative research study with a generic design. Data collection occurred through in-person interviews to gain insight into experiences and beliefs that influenced and shaped participants' safety perceptions. Data analysis followed a thematic approach to code and identify themes among participants' responses. The use of alphanumeric identifiers and securing all files on a password-protected personal computer maintained the anonymity of participant identities. Chapter 4 presents in detail the data collection, data analysis, and themes that emerged from this study.

## CHAPTER 4. PRESENTATION OF THE DATA

### Introduction: The Study and the Researcher

Chapter 4 presents the results of this generic qualitative study on the safety perceptions of firefighters on environmental health hazards and their influence on decisions on personal protection during emergency responses. Data collection entailed conducting semistructured, audio-recorded interviews, with the recordings subsequently transcribed for data analysis. To participate in the study, firefighters had to meet specific criteria based on professional role, length of service, and work location. Participant interviews were a means to gain insight into these individuals' safety perceptions. Findings provide knowledge on emergency response perspectives, safety perceptions, emergency response protocols, PPE use, decontamination procedures, and organizational safety culture associated with firefighters' lived experiences.

A generic qualitative research approach is appropriate when the researcher has knowledge and understanding about a topic yet wants to describe that topic from the participant's perspective (Percy et al., 2015). Personal experience includes current employment by a fire department with 14 years of experience in the field. The span of this career has provided knowledge of emergency operations standard practice and fireground tactics, as well as insight and awareness of the duties of an emergency responder. A background in investigations and training in conducting interviews and interrogations assists with the ability to conduct research interviews with participants to inform the research questions.

Prior experience also includes exposure to many environmental health hazards, with colleagues injured and diagnosed with chronic illnesses from occupational exposures. With cancer rates among firefighters increasing as a result of occupational exposures (Gainey et al.,

2018), exploring the safety perceptions of firefighters may help to determine if there are gaps in understanding leading to poor decisions regarding personal protection. Such lapses on the use of PPE during emergency responses often lead to the development of chronic illnesses among firefighters (Gainey et al., 2018). Changing the safety culture of the U.S. fire service first requires identifying the barriers to safety compliance.

In light of the potential for bias, it was necessary to follow strict guidelines for interviewing and data collection. To further reduce the risk of bias, participants were not friends, colleagues, or members of the same fire department. Another means to reduce researcher bias was utilizing post-interview time for self-reflection. Ashton (2014) suggested that data collection should be unbiased, and the researcher should not prompt the participant to provide an answer the researcher prefers, especially if both parties work in a similar field. Implementing safeguards in the research process facilitated accurate data collection and analysis without the threat of bias.

### **Description of the Sample**

The sample for this study consisted of 17 firefighters working in the Pacific region of the United States. Guetterman (2015) suggested a proper sample size in a qualitative study as being 10 to 15 participants or until achieving data saturation; in the present study, a sample size of 17 was sufficient to achieve data saturation. Each of the 17 participants answered six demographic questions at the beginning of the interview with regard to age, gender, marital status, position held, years of service, and education level. Participants ranged in age from 29 to 60 years, with the majority of participants being male ( $n = 16$ ). All 17 participants were White, 16 of them married. The sample for this study was in alignment with Smith et al. (2016), who found the occupation of a firefighter to be dominated by White males. All participants were career firefighters, as no volunteer firefighters responded to the recruitment posts. Three participants

had attended at least some college: nine had an associate degree and five had a bachelor's degree. Participant ranks ranged from firefighter to captain, with years of service from 6 to 29 years. Table 1 provides each participant's demographic data.

Table 1

*Demographic Information*

| Participant | Gender | Age   | Marital status | Current rank          | Years of service | Education         |
|-------------|--------|-------|----------------|-----------------------|------------------|-------------------|
| P1          | Male   | 45-54 | Married        | Training Captain      | 17               | Bachelor's degree |
| P2          | Male   | 45-54 | Married        | Apparatus Operator    | 29               | Associate degree  |
| P3          | Female | 35-44 | Married        | Lieutenant            | 17               | Associate degree  |
| P4          | Male   | 24-33 | Married        | Apparatus Operator    | 11               | Associate degree  |
| P5          | Male   | 54-64 | Married        | Firefighter/Paramedic | 24               | Associate degree  |
| P6          | Male   | 35-44 | Married        | Lieutenant            | 8                | Associate degree  |
| P7          | Male   | 35-44 | Married        | Lieutenant            | 22               | Bachelor's degree |
| P8          | Male   | 45-54 | Married        | Medical Officer       | 27               | Associate degree  |
| P9          | Male   | 35-44 | Married        | Firefighter           | 18               | Associate degree  |
| P10         | Male   | 35-44 | Married        | Engineer/Paramedic    | 17               | Associate degree  |
| P11         | Male   | 45-54 | Married        | Captain               | 16               | Bachelor's degree |
| P12         | Male   | 22-34 | Married        | Firefighter           | 6                | Associate degree  |
| P13         | Male   | 22-34 | Married        | Firefighter/Paramedic | 10               | Associate degree  |
| P14         | Male   | 45-54 | Married        | Lieutenant            | 28               | Some college      |
| P15         | Male   | 45-54 | Divorced       | Lieutenant            | 12               | Bachelor's degree |
| P16         | Male   | 35-44 | Married        | Captain               | 19               | Bachelor's degree |
| P17         | Male   | 45-54 | Married        | Deputy Fire Marshal   | 27               | Associate degree  |

Although research participants held various positions within the fire department, no one in a management position volunteered to participate. Even so, there was a strong representation of firefighters holding ranks directly involved with emergency response, such as lieutenant. Lieutenants and captains are considered line officers, providing the first line of supervision within the command structure of a fire department. The sample was a good representation of firefighters who served in an emergency response role to inform the research questions.

## **Research Methodology Applied to the Data Analysis**

The data analysis method utilized was the thematic analysis approach. Of the three types of thematic analysis, the most effective is thematic analysis with constant comparison (Percy et al., 2015). The thematic analysis process begins at the start of data collection, with the first participants' data analyzed to code and cluster patterns. The researcher compares these data to the next participant's, continuing this process throughout the entirety of data collection until patterns develop among the participants' responses and themes emerge. Upon completion of interview transcription, the transcripts underwent review to code and cluster patterns, with subsequent review and comparison for reoccurring themes.

Data coding began with a comprehensive review of all interview transcripts for accuracy, followed by printing the transcripts and keeping them secure. Coding techniques included writing thoughts and highlighting specific words, quotes, and phrases within the margins of the printed transcripts, providing an understanding of each participant's experiences and perceptions of environmental health hazards during emergency responses. Similar words and phrases clustered together next underwent categorization into emergent themes. A discussion of the six final themes follows.

## **Presentation of Data and Results of the Analysis**

Transcriptions of all audio-recorded interviews underwent coding to develop themes common among participants. Six themes emerged according to information explained in detail by study participants. In order of frequency from most to least, the themes were (a) risk, (b) training and education, (c) awareness, (d) personal protective equipment compliance, (e) safety culture, and (f) personal protective equipment.

## Theme 1: Risk

All 17 participants discussed the theme of risk and how they assess and justify it during emergency responses. Firefighters take risks based on perceived benefits. A common sentiment among participants was the notion of taking greater risks to save more people, and lesser risks to save less important things, something firefighters hear from the beginning of their careers. P1 stated, “The one thing we always teach in very simplistic terms is ‘risk a lot [to save a lot] and risk little to save little.’” This risk analysis motto is subjective because it leaves the individual to measure the level of risk against the perceived benefits during emergency responses. P8 confirmed this mindset:

So, if someone was—or if there was a known structure fire with kids upstairs that’s known, and you normally would not go into that, you normally would not ladder that, you normally would not do that...I would risk everything.

There is an expectation for firefighters to risk their own lives to save others, something that comes from external and internal expectations. As P11 shared, “Our job as firefighters is to put our lives on the line for things.” This mentality has a strong influence on risk perceptions and influences the amount of risk firefighters are willing to take to accomplish a goal. There is a professional expectation to act, as P1 explained:

Being a training guy, one of the things I always preach is there is no 9-1-2. They are calling 9-1-1 for a reason. So, we can’t show up and say we can’t do anything because it’s on fire. I mean, that is the reason we are there.

This warrior mentality could have an influence on risk perception development among firefighters. In modern culture, warriors are people who serve society at great personal cost to themselves and their families (Malmin, 2013). Occupations include police officers, firefighters,

soldiers, and many others who perform critical services for the community (Malmin, 2013). Society teaches warriors to be resilient and overcome; there are also societal expectations of prioritizing others over self-preservation in dangerous situations (Malmin, 2013). Such statements allude to an expectation of self-sacrifice among firefighters to preserve the lives of others. The need to respond is also applicable to the minimization of risks, the consequences of which are not immediately visible. These statements support Maglio et al. (2016), who suggested that firefighters often suffer from goal seduction, which influences taking inappropriate risks with hazards they believe interfere with completing their goal. Internal job expectations also play a role in risks taken during emergency responses. Firefighters want to perform their job when responding. With the number of structure fires declining in the United States, firefighters may take unnecessary risks during emergency responses, fueled by momentum. P6 explained this experience:

It's supposed to be that if it's a house we are saving, we are not going to risk a whole lot, but we are firefighters and we get amped up and we want to do what our job is and that is to put out fires. So, I think the majority of [firefighters] risk a lot, even to save little. So they will put themselves into harm's way, into the hot zone, and work extra hard to put out a house fire, even if there is nobody in it.

Risks taken by firefighters are instrumental, as the goals of the profession include helping others, goodwill, safety, and social order (Prochniak, 2014). Firefighters increase the degree of risk taken when lives are in danger; however, they may also risk a lot to save little. Participant statements supported prior research findings that risks are often associated with firefighters' drive to achieve goals during emergency responses.

## Theme 2: Training and Education

Firefighters receive extensive training to learn the key job functions for emergency response. This level of training is the reason firefighters' risk perception of emergency situations differs from that of the general population (Hahm et al., 2016). Firefighters are equipped to respond to emergencies with proper knowledge and the equipment to execute their duties (Hahm et al., 2016). The participants in this study ranged in education from some college education to holding a bachelor's degree. A common theme discussed by the majority of participants was that perceptions of environmental health hazards formed from the training and education they received on the subject. For P16, training and education was the most important method of preventing firefighter injuries and minimizing occupational exposures. The respondent stated, "To me, [safety] begins a long time before the response, in properly training my crew to recognize what hazards are present in an event like that and how to address them." Participants with knowledge of occupational exposures were more likely to wear PPE at every emergency response. P10 said, "I think that the awareness that training has done has opened my eyes to how serious the exposures are and how much we don't know about the risks of some of these exposures."

Participants were also more likely to take part in post-exposure decontamination procedures after emergency responses. P10 enforced this conclusion on the subject of fireground hazards: "If there is a known hazard, I may take the necessary steps to mitigate that hazard and reduce my exposure to that hazard that I can." When asked what determines the level of risk firefighters are willing to take on an emergency call, P4 responded, "A lot of it is training. Is this something that we have been trained to do?" Staying current on the latest training and education on occupational exposures has led to new decontamination procedures among the participants'

agencies. P3 shared the details of this process at her agency: “So now we have a procedure—you are wiping off your face, neck, and hands. You are putting on gloves, taking off your turnouts at the scene, and doing some gross decon[tamination] at the scene.”

Training and education are essential in influencing firefighter risk perceptions. In a study of such perceptions, Rodríguez-Garzón et al. (2016) explained that firefighters with higher levels of training and education demonstrated higher awareness of risk than did other firefighters. Training and education in environmental health hazards provide firefighters with the tools to make better decisions on personal protection and methods to decontaminate themselves after structure fire responses.

### **Theme 3: Awareness**

The training and education levels of firefighters vary across the United States, heavily influencing firefighters’ awareness of environmental health hazards during emergency responses. Awareness comes when individuals have an understanding of the issues and concerns. Another theme among the research participants was that firefighters are aware of the environmental health risks encountered during emergency responses to structural fires; however, the level of knowledge varies. Some participants spoke in depth about their knowledge of environmental health exposures encountered during emergency responses, whereas others struggled to articulate the connection between occupational hazards and their health. When asked about what environmental hazards firefighters are exposed to during emergency responses, P6 stated, “Definitely smoke and carcinogens and all the synthetic materials that are burning.” All participants were aware of current research on occupational exposures and the connection to firefighter cancers. P4 stated, “We are in a profession where you think you take enough

precautions against things that will give you cancer, [but] there is something new out there every day that may...harm you.”

Firefighters also understand that environmental health hazards faced during emergency responses can become long-term problems. P5 said, “It’s cumulative. The things that we are exposed to in little bits at a time add up.” It is difficult for firefighters to not observe the consequences of long-term occupational exposures. P14 shared,

I am on the backside of my career now and you just don’t see that many 70-year-old retired firefighters. As you get to the end of your career, that kind of starts to hits home. You don’t see many firefighters that last long after they retire.

The awareness of long-term health problems is even greater when firefighters have personal connections to occupation-related cancers. P17 stated, “It seems to be, in my experience with people I’ve known in the service that die or die when they’re older, it tends to be cancer-related.” Such experiences motivated P17 to make positive health changes and influenced decisions on personal protection during emergency responses. P8 shared, “I have friends that have cancer; I have friends that have died from cancer in the fire service. It’s a ticking time bomb that you never know.” P8 said the connection has made him think about career longevity and has inspired personal changes in PPE compliance and post-fire decontamination procedure participation.

#### **Theme 4: Personal Protective Equipment Compliance**

With all the research available to members of the U.S. fire service, PPE compliance during emergency responses remains a problem. Participants said they discontinued the use of PPE during emergency responses if they perceived it got in the way of performing their duties. P16 shared discontinuing PPE because of “interference with the job,” with P11 similarly

discontinuing “when whatever it was hinder[ed] me from accomplishing something.” P14 gave an example of discontinuing PPE use, saying, “I’ve had to peel off my helmet or coat to get into a crushed car to help a victim, and that was more acceptable.” In discussing exceptions made to wearing PPE during emergency responses, P6 responded, “I think, realistically, it’s life safety. If I know that I need to do something right now and to make a difference and save someone’s life, then I think that’s the biggest one. And inconvenience would be the other.”

Once the fire is extinguished, PPE compliance may be even laxer among firefighters, especially in the salvage and overhaul phase of the emergency response. Asked why this is the case, P10 explained, “There is a lot of peer pressure to not wear your air packs, because then we have to fill bottles and all that kind of stuff that we dealt with when we started.” This negligence is also common among firefighters with regard to post-fire decontamination procedures. P5 said, “Getting your gear washed is a personal thing at this point; it’s quasi-mandatory. I mean, we are supposed to, but there is no check-off that you do; there is no follow through on that.” Statements like these indicate why training, education, and safety culture play such vital roles in protective measures among firefighters.

One of the barriers to compliance with PPE decontamination procedures was an emphasis on getting back in service after a fire response, needing to be prepared for the next emergency call, no matter the size of the agency. P2 explained,

[It] depends on the battalion chief. Some of them totally subscribe to your totally being out of service ‘til you are cleaned up and have your engine back in service. And some of them are, “Get back to the station as soon as you can and get back into service.”

Another barrier to PPE decontamination was the time it takes to wash turnout gear after fires and having only limited access to turnout washers (also known as extractors). P1 explained,

We have one turnout washer and you can only do so many turnouts in at a time, so it's quite the process, actually. If you get a crew back—let's say you got four, five people that went out on a fire—more than likely, it's going to be up to the next crew to continue washing turnouts for you. Just because it takes so long, as you know. And put them in the dryer, and all that sort of stuff.

One group of fire department members that does not get much attention is fire investigators. Some participants said that fire investigators' PPE compliance is an issue, as well. P1 reported observing fire investigators not wearing full PPE in post-fire environments. When asked if such noncompliance was due to lack of gear or awareness, P1 said,

I don't think it's lack of gear; I think it's personal choice. I've been in fires before and after the fire has died down, overhaul is pretty much done at that point. I still have on everything, except I'm not breathing air and I will be standing beside a fire investigator [who] has nothing on but their regular duty uniform.

Asked why he thought this was, P1 continued,

I think that's a personal choice, but I think they have the opportunity to jump into some coveralls or whatever. But I think they just want to get in there and they want to get their job done. They [have] tasks that they are doing, but they might not realize that they are taking some of those harmful particulates or whatever back with them.

Noncompliance in fire investigators is not an uncommon practice, as noted by P11 when recalling a period during which he conducted investigations. "The chief that I worked with, he and I would do an investigation, and during our investigation, we never did have any SCBA or any other; we didn't wear anything." P17 described his normal attire for conducting fire investigations:

Sometimes...I do the investigation, but I don't wear anything other than maybe my duty uniform or a pair of coveralls. Where I probably should either be in a parka or Tyvek and a pack, or at least at a minimum an oral-nasal APR.

PPE used by fire investigators differs from that of firefighters. P3 explained, "We have a different set of boots we use, and we have coveralls that we wear. And then the APRs...have real light construction-worker helmets instead." This gap in PPE compliance and PPE allocation is significant when looking at occupational exposures.

### **Theme 5: Safety Culture**

Safety culture is the environment in which the social structure of the organization supports the importance of safety by the group as a whole (Lundell & Marcham, 2018). Only leadership can drive and develop a safety culture (Lundell & Marcham, 2018). Organizations that had the most success with PPE compliance shared a common theme in strong leadership support for safety and PPE compliance. Participants whose fire chiefs set the standard that all firefighters are to wear their PPE during emergency responses saw fewer issues with noncompliance. Participants with strong leadership support for safety also experienced individual accountability as well as peer-to-peer accountability. The message has to be clear from the top, as P2 explained:

I think it's a leadership problem. I think it needs to come from the top down. The chief—not a battalion chief, not a station captain—the fire chief needs to emphasize to everybody, from his level all the way down to the recruit firefighter, how important PPE is and how to wear it.

The message needs to be clear, and it must become a priority for leaders. P2 expanded further:

Everyone knows that the culture is customer service, customer service, customer service, and they come first, the taxpayer comes first; everything we want to do is we don't want to miss a vote because we are so vote-dependent for funding. And everyone takes that to the extreme because that is the message that comes from the top. Now, if the same message that came down is health, safety, and awareness, then I believe everyone would take that to heart.

Participants with strong safety cultures explained that PPE compliance was due to a clear expectation of use during emergency responses. P3 described the expectation for her agency:

Our department is very firm on, "You always wear your gear." So even if you are out and about doing an inspection, you pop a structure fire, you are driving down the road, you get out, you stop and get out and put on your gear on and get ready. Because, as we know, once we get on scene, you can get distracted and you never get the rest of your gear on until much later.

P14 stated:

I don't think there [are] any exemptions in our department. You know, there are standard operating procedures and they are in written format. And those are the expectations. I can't think of a time—and like I said, I've been involved in a bunch of exposures—that it was never OK not to wear your protective equipment.

In addition, a strong safety culture can create positive peer pressure that alters habits from past practices. P11 explained:

Now it's very consistent, and we are doing a pretty good job of changing the tide of that thought process to where it's—everyone is becoming more self-conscious about it and policing themselves, and if they don't, then it falls to everyone else around us. And

everyone is getting to the point where we kind of call people out for it. We are not putting up with that near to what we used to.

These comments allude to a changing tide in peer pressure among firefighters influencing positive safety behavior. With a strong safety culture, positive safety behavior could continue to reduce the compliance issues with PPE use during emergency responses. As indicated, however, an agency's safety culture is dependent upon its leadership.

### **Theme 6: Personal Protective Equipment**

All 17 participants said their agencies provided them with standard sets of PPE, which included firefighter turnouts, helmet, gloves, boots, protective hoods, and SCBAs. Participants believed their agencies put forth the best effort in giving them the necessary gear to protect them during an emergency response. P11 said:

They do a very good job of providing stuff for us, and they are also very good at listening if we do have a need. They will listen to it and we will have conversations and see what needs to happen.

This sentiment is similar to what P16 shared: "One thing we are not wanting for is PPE. Our current fire chief came out of health and safety; he has a very heavy emphasis on health and safety procedures." Most agencies also provide their career staff an additional set of turnout gear to change into after structure fire responses. P1 discussed having two sets of gear:

Luckily enough, the career people have been provided with two sets of turnouts. So as soon as we get back, we can swap one out and we can wash the other set. Volunteers and interns can go see if there is another set available to them in our turnout room. So that's good in one regard, [that] our second set of turnouts is hanging in the bay.

Thus, the gap in protection is not a lack of gear, but a lack of understanding of how and why to use it properly.

There is an overreliance on air gas monitors to identify necessary levels of respiratory protection. All research participants stated that their respiratory protection policies were based on utilizing air gas monitoring equipment to obtain air readings. When asked what determines the need to transition from an SCBA to an air-purifying respirator, P3 said it was whether the gas meter was alarming. Most participants said their agencies provided them with a four-gas monitor; however, it does not capture all the potential gases present in a post-fire environment. P12 said, “We will have our investigators show up and they will run their monitors through the scene. So we will be able to stay on air until it’s safe to breathe the air.” The participant expanded on this statement, saying, “If it’s deemed that it is safe, then I think it would be OK to go in without air or our masks on.” Statements like these enforce the importance of education and training, both on the hazards from which PPE should protect firefighters and on how to properly use the equipment assigned to them.

One of the challenges faced by some participants’ agencies was budgetary constraints. Although the current common practice is to provide firefighters with two sets of turnouts so they have a set to change into after a structure fire response, some agencies cannot afford two sets. P8 shared how this is still a challenge for some agencies.

You know, at least we have a second set of gear, where some departments don’t have the ability to afford that. You are in the eastern part of the state or maybe you are a volunteer fire department that can’t spend that kind of money for a second set of gear because it’s expensive. So, I feel lucky enough that I have a second set of gear to get into.

Another challenge may be replacing gear when it is damaged or expired. P15 discussed this dilemma:

For us, in a small department, the budgets are tight, and we need to plan ahead [for] when our bunker gear is expiring, when it gets damaged beyond repair, or things like that.

Unfortunately, my department doesn't have the funds to just go out and purchase another set of gear on a whim.

Overall, participants agreed that their agencies made an effort to provide them with the gear necessary within their budgetary constraints. P3 captured this shared belief with this statement:

Barriers are always money; I don't think there is a lot of resistance otherwise. Like I said, our chief, our current chief right now, [and] our battalion chief are on board with being safe and safety conscious. [But it depends on] cost and working with a budget. On anything else—getting dryers, more extractors, or getting hoods you can throw away and things like that.

Common practice among represented fire agencies to reduce exposures from fire responses is to provide firefighters with two sets of turnouts, allowing them to change into a clean set after a structure fire response and decontaminate their exposed PPE. Depending on the size of the agency, however, achieving this practice may be a challenge due to budget limitations.

### **Summary**

This chapter presented descriptions of the study and the researcher, portrayal of the sample, research methodology applied to the data analysis, and the results of qualitative semistructured interviews with 17 firefighters actively involved in emergency response roles.

The means of data analysis was thematic analysis with constant comparison. Data analysis revealed several themes in response to the research questions on the perceptions of firefighters regarding environmental health hazards and their influence on personal protection during emergency responses. Six themes emerged according to information explained in detail by study participants. In order of frequency, the themes were, (a) risk, (b) training and education, (c) awareness, (d) personal protective equipment compliance, (e) safety culture, and (f) personal protective equipment. Findings from this study could provide insight into safety program development to minimize injury and death among U.S. firefighters. Chapter 5 contains an overall summary of the study, including a discussion of the results, conclusions based upon the results, limitations, implications of the study, recommendations for further research, and a conclusion.

## CHAPTER 5. DISCUSSION, IMPLICATIONS, RECOMMENDATIONS

### Summary of the Results

This generic qualitative study involved conducting semistructured interviews with 17 participants to gather data sufficient to answer the two research questions. Use of a thematic analysis approach during data analysis was appropriate to develop six themes, which were: (a) risk, (b) training and education, (c) awareness, (d) personal protective equipment compliance, (e) safety culture, and (f) personal protective equipment. Firefighters based the risk taken during emergency calls on the perceived benefit and the internal and external occupational expectations. Firefighters in this study stated that increased risk on the fireground is warranted when there is a life at risk. Study findings indicate that firefighters can often experience tunnel vision amid a rescue, which could lead to injury or death.

The literature reviewed included research studies, texts, and peer-reviewed journal articles regarding behavioral theories, safety behavior, safety perceptions, firefighter health hazards, and heroism and altruism. The literature review provided insight into current research on these topics and opportunities for advancing academic knowledge. Prior research indicated that, in responding to emergency situations, firefighters face many hazards that may have immediate and long-term health effects. Firefighters tend to focus on immediate hazards, with long-term health hazards often an afterthought. Current research has shown safety behaviors to be associated with safety perceptions (Prati et al., 2013). This study sought to gain insight into firefighters' safety perceptions and how they influence safety decisions on personal protection during emergency responses.

The purpose of this study was to explore firefighters' perceptions of environmental health hazards and how these perceptions influence personal protection use during responses. The knowledge obtained in this study may provide fire department officials better awareness of safety behaviors among firefighters, enabling them to determine gaps in risk perception that increase firefighters' risk of injury or death. Risk perceptions develop through individuals' judgments and evaluations of the potential hazards that may cause them harm (Joseph & Reddy, 2013).

In line with other studies, findings showed that training and education significantly contribute to shaping firefighters' risk perception. Firefighters in this study explained that understanding fire behavior and in what environments victims are likely to remain viable rescues was important in determining appropriate risk decisions on the fireground. Training firefighters on how to recognize hazards that pose immediate threats to long-term health will assist them in developing an appropriate risk-versus-benefit analysis. Staying current on the latest trends and research on fire exposures can help supervisors in developing and revising existing policies and training programs. The more training and education firefighters have, the greater their awareness of occupational exposures and health hazards.

Most participants were aware of links between occupational exposures and cancer incidence among firefighters. Participants shared how such awareness made them consider hazards associated with emergency responses and participation in post-fire decontamination procedures. Many participants stated that awareness of these risks had led to changes in the level of personal protection they take during emergency responses. Some respondents had adopted a defeatist approach to structure fire exposures and explained that, regardless of their actions, there would be potential mortality outcomes from a career of exposures. When cancer diagnoses and

deaths occurred among fire department members who were close to the participants, awareness of occupational exposure increased and resulted in behavioral changes. All participants explained that training and education on the latest information on occupational exposures and personal protection measures influenced their level of risk awareness.

Firefighter participants said their departments provided all members with PPE, including turnouts (jacket and pants), fire helmet, protective hood, boots, structural gloves, and SCBAs. Challenges arose when some departments were unable to afford a second set of turnout gear for everyone. Some participants also stated that their agencies purchased additional sets in common sizes and that it would be difficult after a fire to find a second pair that fit. Another challenge was the storage of second sets of gear at remote locations, impeding some firefighters from changing out their gear. Participants who did not have a second set of turnouts were unable to change out of exposed gear after structure fire responses; in addition, if the second set of gear was not in a convenient location, firefighters would be less likely to wash their gear after a fire because they needed it for the next call.

All participants reported having an air gas monitor assigned to them, with either three or four gas sensors to monitor oxygen and hydrogen sulfide and to lower explosive limit and carbon monoxide. Participants said they used the devices to monitor post-fire sites to identify IDLH environments, which helped with decisions on appropriate levels of respiratory protection during post-fire activities (e.g., salvage and overhaul operations, fire investigations). There were inconsistencies with knowledge of gas detection levels among the participants. According to some department protocols, if air gas monitors were not alarming, then it was appropriate to remove SCBAs. This inaccuracy is an area of concern, as air gas monitors do not include sensors for many of the known toxins present in post-fire environments. In addition, air gas monitors do

not account for other harmful building materials that could be in the air, such as asbestos and insulation.

Participants in this study alluded to a current trend within the fire industry of implementing post-fire decontamination procedures to minimize structure fire exposures. This practice involves gross decontamination on the fireground after fire suppression, with firefighters washed down with water and soap to remove toxins from structure fires. Compliance with these procedures varied among the fire agencies where participants worked. Also, issues arose concerning the effectiveness of post-fire decontamination methods, which ranged from using only water to wash down firefighters to using soap and water with a scrub brush. Another component of post-fire decontamination was placing their gear into turnout washers (extractors) and showering as soon as possible after returning to their stations. Barriers firefighters faced in participating in post-decontamination procedures included pressure to get back into service, inconvenience of extractor locations, limited number of extractors for firefighter gear after fires, and inconvenience of participating in the process.

Finally, firefighters explained that safety culture played a significant role in safety behaviors within the organization. Strong leadership support for safety programs and compliance with safety procedures during emergency responses created a strong safety culture. When executive fire officials provided clear expectations of safety, firefighters were more likely to participate in safety programs and regulate one another. When firefighters did not see leadership support for safety, they were part of a safety culture without clear expectations and gaps in PPE compliance during emergencies. These gaps are of significant concern, as they lead to poor safety behaviors that could have negative health outcomes for firefighters.

Findings from this study support the important role training and education play in the development of firefighters' risk perception and influencing the awareness level among firefighters. The more training firefighters have on hazards associated with emergency responses, the more likely they are to participate in post-fire decontamination procedures. Study findings showed that firefighters tend to focus more on immediate hazards than on those for which the consequences do not emerge until later into their careers. Participants explained how safety culture was strong when fire department leadership clearly prioritized safety and the expectation for firefighters to comply with safety procedures. All 17 participants shared that their agencies provided them with the basic allotment of PPE for emergency responses. Not uncommon, however, were budget constraints, with agencies struggling to supply firefighters with a second set of turnout gear as a means of reducing exposures from structure fire responses. Another frequent theme was that PPE compliance was still a struggle among firefighters.

### **Discussion of the Results**

Two research questions guided this study, as follows:

**RQ1.** What are emergency responders' perceptions of environmental health hazards in emergency responses?

**RQ2.** How do risk perceptions influence emergency responders' decisions in the use of personal protection in emergency responses?

Firefighters who participated in this study are aware that there are harmful toxins present at every structure fire to which they respond. They understand the link between long-term exposures and the development of chronic illnesses in later years. The more education and training firefighters have on the subject of environmental health hazards, the more likely such knowledge will influence their risk perception. Firefighters need frequent training and education

on emergency response hazards so that they have the information necessary to develop their risk perceptions, which influence decisions on safety protection.

Findings from this study supported the assertion that risk perceptions influence safety behaviors. Firefighters decide on the level of risk they are willing to take based on the perceived benefit from their actions on emergency calls. These decisions exemplify altruistic behavior through firefighters' desire to serve their community. Therefore, decisions on personal protection are based on firefighters' perceptions of the risk and what they deem is appropriate protection for the hazard. Firefighters can more accurately determine benefits gained from such risk-taking behavior when provided with training and education that develops their risk perception. Without receiving proper training, firefighters may make decisions based on inaccurate risk analysis, leading to injuries or fatal outcomes.

Findings from this study indicated that firefighters also have knowledge gaps regarding PPE compliance and understanding of safety instruments used during emergency responses. Firefighters are aware their stations provide PPE for their protection; however, they may remove the equipment if they feel it is inconvenient, is in the way of goal completion, or will delay a victim rescue. These excuses stem from perceptions, which can vary among firefighters. Gaps in understanding how to use safety instruments such as air gas monitors can lead to premature removal of respiratory equipment and inaccurate perceptions of atmospheres as being safe. During semistructured interviews, firefighters frequently expressed that their agencies based the use of respiratory protection equipment on readings from air gas monitors that measure only three or four gases. Data analysis showed protocols varied from no respiratory equipment required when the air gas monitor does not alert to the removal of equipment a set time after fire extinguishment. An area of concern is that although a gas monitor does not go into alarm mode

for IDLH environments, the atmosphere may not be safe for breathing without respiratory equipment.

### **Conclusions Based on the Results**

Research has shown that exposures at fire scenes include not only gases but also smoke particles inhaled or contaminating skin or clothing (Fabian et al., 2014). Fire scene exposures are associated with an increased risk of cancers of the stomach, colon, rectum, skin, and brain (Glass et al., 2016). Based on these findings, the International Agency for Research on Cancer classified occupational exposures during firefighting activities as possibly carcinogenic to humans (Gainey et al., 2018). Fire scene toxins of concern to firefighters fall into four categories: asphyxiants, irritants, allergens, and carcinogens (Fabian et al., 2014). Smoke particulates present during structure fires may include the following toxins: ammonia, carbon monoxide, hydrogen cyanide, hydrogen sulfide, nitrogen dioxide, sulfur dioxide, polycyclic aromatic hydrocarbons, and phthalate esters (Fabian et al., 2014). Acute exposures to these chemicals can have immediate health effects or result in the later development of chronic illnesses (Fabian et al., 2014).

Although the majority of researchers studying fire scene exposure have primarily focused on firefighters, Davis, Tao, Bernacki, and Alfriend (2012) shifted this focus to fire investigators after the Bureau of Alcohol, Tobacco, Firearms and Explosives experienced a cluster of bladder cancer incidents among their agents assigned to post-fire investigations. Six of the seven individuals with bladder cancer in this study had occupational histories of working post-fire scenes while employed with the Bureau (Davis et al., 2012). Increased incidence of bladder cancer appeared to be associated with the performance of post-fire and post-blast investigations. Post-fire scenes may expose firefighters to a mix of hazardous chemicals and products of incomplete combustion, which include known and suspected carcinogens (Davis et al., 2013).

Post-fire environments pose an exposure concern for firefighters due to the smoldering of synthetic materials and the release of trapped gases from porous materials through mechanical disturbances during overhaul and fire investigation activities (Davis et al., 2013). Overall, occupational exposures significantly contribute to the risk of adverse cancer outcomes (McClure et al., 2019).

Because so much research shows a link between occupational exposures and the development of chronic illnesses, it would be significant to the profession to know how firefighters' perceptions of these hazards influence their decisions on personal protection. Risk perception, the internal analysis of the probability of negative consequences when evaluating potential hazards before making a decision (Joseph & Reddy, 2013), is associated with injury and safety behavior (Prati et al., 2013). Individual perceptions of direct benefits also influence risk acceptance (Slovic, 2012). Risk perception stems from an individual's subjective awareness of potential harm from a hazard and the internal analysis of risk information available (Martin et al., 2016). This study provides further academic information on firefighter risk perceptions and how they influence decisions on personal protection during emergency responses.

Researchers have found that individuals perceive and interpret risk differently (Hahm et al., 2016). Although risk can be subjective, research has shown risk perceptions to be associated with injury and safety behavior (Prati et al., 2013). Risk perception by experts is more accurate than among laypeople (Hahm et al., 2016). Firefighters are experts in emergency responses due to their frequency of exposure to such situations (Hahm et al., 2016). Firefighters perceive a higher level of control over the dangers of their occupation due to experience with those hazards on previous emergency responses (Hahm et al., 2016). This research study supported such findings, further exploring why firefighters take those risks.

Study participants related basing the risk taken during emergency response calls on the perceived benefit. Firefighters shared that if there were a life in danger, they would take great risks to save the victim. Many of the participants attributed this drive to both internal and external expectations. The public anticipates firefighters will do what is necessary in emergency response. There is also a professional expectation that it is an emergency responder's job to do whatever it takes to preserve life. Research participants explained that their risk assessments during emergency responses improved with experience and training. Participants shared that, at times, they could get so focused on the goal of trying to save a victim that they would place themselves in unnecessary danger.

### **Comparison of Findings With Theoretical Framework and Previous Literature**

Findings showed consistency with the firefighter motto of “Risk a lot to save a lot, risk little to save little” (Scarborough, 2017, p. 1073). This adage serves as a general risk management gauge to determine which risks are worth taking during an emergency call. The problem, however, is that the motto is based on perceived benefit gained from risk-taking during emergency calls. A variety of factors shape perceptions, such as experience, morals, training, and expectations. There are societal and professional expectations for firefighters to be risk-takers (Maglio et al., 2016), as affirmed by the participants in this study. Altruism among firefighters is an important reason why they are willing to take risks during emergency responses (Zinn, 2015). The core mission of firefighters is to make a difference in the communities they serve, a desire that sometimes conflicts with self-preservation behaviors. Individuals motivated by altruism are aware of the risks but willing to tolerate them to contribute to the well-being of others (Zinn, 2015), a characteristic apparent in participants' statements. These expectations and drives could have a direct influence on risk-taking decisions during emergency responses.

Safety climates within a fire organization have a strong impact on firefighters' risk perceptions. Strong leadership support for safety and compliance with safety programs clearly outlines acceptable behavior for firefighters. Findings from this study align with those of Smith et al. (2016), who found leadership styles influenced firefighters' safety perceptions and safety behavior outcomes during emergency responses. Passive leadership approaches to safety led to issues with PPE compliance and adherence to safety procedures during emergency responses. As Smith et al. (2016) noted, passive leadership—also described as the absence of leadership—can be a destructive approach because it indicates indifference about tasks and workers. Passive leadership may appear in the form of leaders' expectations that workers will self-regulate and comply with safety protocols. As previously discussed, a variety of influences shapes firefighters' risk perceptions that direct safety behaviors, with strong leadership commitment to safety having a positive influence on organizational safety culture.

Historically, firefighters would not wear their SCBAs during overhaul due to concerns over heat stress and weight; however, regulations shifted to requiring SCBAs for all fires (Fent et al., 2018). Similar to findings by Gainey et al. (2018), this study showed that challenges remain with respiratory PPE compliance among firefighters, especially during overhaul operations. According to Fent et al. (2018), fire officials often sought guidance to determine when respiratory protection was no longer needed to combat issues with heat stress during emergency responses. Firefighters frequently remove respiratory protection when the fires are extinguished and they perceive their environment to contain clean air (Gainey et al., 2018). This study was in alignment with Gainey et al.'s findings, as participants discussed observing such safety behaviors during emergency responses. Also discovered with the current research was that overdependency

on air gas monitoring equipment also led to misjudgments on the removal of respiratory PPE during the salvage and overhaul phases of an emergency response.

Rational choice theory application in the field of emergency management was lacking before this study. Rational choice theory implies that individuals' beliefs, preferences, and constraints drive their choice of actions (Manzo, 2013). As mentioned, rates of injury among U.S. firefighters remain high. Gaining insight into choices made about personal protection during emergency responses may be valuable to fire agency officials in injury prevention program development. Research findings indicated that rational choice theory may be applicable to this field as a method to understand choices made by firefighters. Firefighters, by their profession, are driven by service for others through altruistic acts. Firefighters' perceptions of hazards will influence safety behavior during emergency responses.

### **Interpretation of the Findings**

Firefighters understand their occupation has inherent risks. These professionals perceive and interpret risks differently, with their subjective assessments influenced by many factors such as job expectations, personal beliefs, education, training, and organizational safety culture. There was consistency in how participants determined risk during emergency responses based on the perceived benefits. Societal and professional expectations for firefighters are to act during emergency calls. Firefighters have a deeply held belief that self-sacrifice in the pursuit of saving lives is among the highest honors in their profession. Firefighters believe these expectations are part of their duty, and that risk is inherent with every emergency response. This finding is also consistent with risk-taking among individuals motivated by altruism, or the desire to help others for the common good.

When faced with choices, individuals tend to make decisions based on the perception of which option is the most rational choice (Baillon et al., 2016). Rational choices within the U.S. fire service stem from the commitment to serve their respective communities and expectations to act in dangerous situations. An organization's safety culture has a strong influence on risk perception development. Leadership commitment to safety programs, purchase of PPE, and enforcement of safety protocols assist with identifying rational choices during emergency responses. Firefighters are goal-oriented individuals who can become goal-seduced during emergency responses, subsequently making poor decisions regarding personal protection.

Themes identified in this study informed the research questions. Firefighters in this study are aware of their exposure to environmental health hazards associated with the development of chronic illnesses in later years. Firefighters understand that exposure to harmful toxins is one of many inherent risks in their occupation and accept these risks. In addition, participants were unanimous in asserting that training and education improved their risk awareness, providing knowledge for them to make better choices during emergency responses. Ultimately, firefighters' decisions on personal protections and risks taken during emergency responses came from the perceived ability to save lives.

### **Limitations**

Limitations of this study included the use of snowball sampling, which introduces selection bias. Snowball sampling necessitated depending on a small pool of initial volunteers to nominate additional individuals who met eligibility criteria for this study. Additional limitations included the demographics of the sample. Participation was open to firefighters in the U.S. Pacific region who were active in emergency response roles. Although being a career firefighter was not a requirement, no volunteer firefighters expressed interest. Volunteer firefighters

represent 69% of the 1.3 million active firefighters within the United States (Henderson & Sowa, 2018). As they comprise such a large percentage of the occupation, exploration into the perceptions of volunteer firefighters would be beneficial to increasing the knowledge of risk perceptions within the U.S. fire service. It would be interesting to explore whether there are differences in risk perception between career and volunteer firefighters.

Another group with low participation was female firefighters, only one of whom took part in the study. Although this is a small number among 17 participants, it is consistent with the composition of the U.S. fire service, with females representing 3% to 5.1% of all firefighters (Jahnke et al., 2019). These demographics were not unexpected because firefighting is a White male-dominated occupation (Phelps et al., 2017; Smith et al., 2016). Research has shown that women are more risk-averse than men, perhaps due to the self-assessment they conduct when faced with choices (Fisk, 2018). It would be interesting to determine if gender differences in risk-taking behavior apply to the occupation of firefighter. In researching risk perceptions and influences on decisions regarding personal protection during emergency response calls, further study into gender differences could be of significance to the field.

### **Implications for Practice**

This study shows the importance of safety perceptions and the role they play in safety behaviors. Researchers have found an association between risk perception and injury and safety behavior (Prati et al., 2013). With this insight into firefighters' perceptions of environmental health hazards and how these perceptions influence decisions on personal protection during emergency calls, fire officials can develop effective safety programs. Study findings reinforced how a strong safety culture within an organization influences firefighters' risk perception. Findings showed that a clear message and commitment to safety coming from organizational

leaders has a positive influence on firefighters' safety behavior. Training and education of safety hazards and proper use of safety equipment are important in developing a firefighter's risk perception. The research on environmental health hazards and the development of chronic illnesses from repeated exposures is ongoing; accordingly, fire officials must stay abreast of the current knowledge on fire exposures and methods to protect fire department personnel during emergency responses.

Study findings showed a continued problem with PPE compliance among firefighters. Maglio et al. (2016) addressed PPE compliance challenges in post-fire suppression phases such as salvage and overhaul, which this study confirmed to be an area of continued concern regarding PPE compliance. Findings showed PPE compliance issues among fire investigators, a group of fire agency personnel often overlooked in previous studies. Participants reported observing lax PPE use by fire investigators during fire scene investigations. Research participants shared personal experiences in which PPE use, primarily respiratory protection, varied in post-fire suppression situations. To explore this issue, semistructured interviews included questions regarding policies for PPE use in post-fire suppression phases on emergency response and when it was appropriate to remove respiratory protection. Research findings indicated an area of concern with firefighters' lack of knowledge of appropriate use of gas monitors in determining respiratory protection requirements in a post-fire setting. Such errors on firegrounds open firefighters to exposure from harmful carcinogens and health hazards not detectable by this equipment.

Harrison et al. (2017) found a conflict between the short-term efficacy of organizations' mission and long-term risk reduction. The researchers found similar conflicts among firefighters who must balance immediate organizational requirements and long-term needs for reducing

potential cancer exposures. By way of illustration, Harrison et al. noted the desire to rest and be quick-minded for future emergency calls versus the need to clean gear after exposures from fire responses. Participants in the present study reported short-term conflicts in having to get back into service for the next call and being too tired after a fire response to take adequate time to change into clean gear or decontaminate PPE after exposures.

This study expanded the application of rational choice theory to firefighters' risk perceptions and decisions on personal protection during emergency responses. In accordance with rational choice theory, individuals' beliefs, preferences, and constraints influence the choices they make (Manzo, 2013); this study's findings showed firefighters' choices to be influenced by similar factors. Rational choice theory does not imply that individuals' actions are only self-oriented (Manzo, 2013); rather, individuals can act outside of their self-interest to behave in an altruistic manner (Lemieux, 2014; Zinn, 2015). Altruism is in line with the professional expectations of firefighters to take necessary risks to preserve life, as previously described by Maglio et al. (2016). Study findings were that risks taken by firefighters were justified based on the perceived benefits and options they perceived at the time of the emergency response. Under rational choice theory, an individual's beliefs do not have to be correct and the individual's perceptions of available options are subjective (Manzo, 2013). In interviews, this study's participants repeatedly asserted that high risks to include possible injury and death are justified if the perceived benefit was saving a life. Findings showed that firefighters' risk perceptions focused on the immediate life and safety risks, with long-term risks tending to be an afterthought.

## **Recommendations for Further Research**

### **Recommendation 1**

Two areas warrant future research. First, fire investigators merit consideration. An often-overlooked phase of fire suppression operations is the post-fire investigation phase, as departments are responsible for determining fire origin and cause. There is as yet limited research on the environmental health hazards present in a post-fire environment as well as the PPE used during these operations compared to structural firefighting. Participants in this study identified discrepancies with PPE use and compliance among those involved in fire scene examinations. Some respondents suggested that decisions on PPE may stem from personal use, whereas others mentioned variances in PPE among fire investigators as opposed to firefighters. In addition, participants revealed inconsistent understanding of the environmental health hazards present during post-fire investigations. Insight into the safety perceptions of fire investigators may inform the research community and field of risk management of any gaps in hazard assessments.

### **Recommendation 2**

Another area for expanded research would be to study wildland firefighters. Participants related finding a lack of available respiratory equipment at wildfire sites that would normally be available for structural fire responses. There are currently many unknowns related to firefighter exposure to wildland fire smoke (Adetona et al., 2016). Although there have been no direct links to diseases, studies have shown decreased lung function among firefighters having worked shifts in a wildfire setting (Adetona et al., 2016). With this gap in knowledge, gaining insight into the PPE provided, the general awareness of health effects, and any health-related outcomes during or after wildfire exposures may provide insight into the field.

## Conclusion

Researching the safety perceptions of firefighters regarding environmental health hazards during emergency responses and how those perceptions influence decisions on personal protection presented insight into how risk perceptions influence safety behavior. One discovery was that firefighters' risk perceptions have a direct influence on decisions of personal protection during emergency responses. Risk perceptions stem from a firefighter's experience, training, education, safety, cultural beliefs, and desired outcomes. Firefighters clearly understand their occupation comes with inherent risks and that, during emergency calls, immediate life safety risks take priority. Firefighters take risks based on perceived benefits. A common belief among firefighters is greater risks are necessary with the possibility of saving more (e.g., preserving a life), with fewer risks taken for less important things (e.g., property). There is a common expectation that firefighters must be willing to self-sacrifice to save others. Long-term risks may be an afterthought for firefighters, even though they understand these risks can lead to negative health outcomes in later years. It is difficult to shelter firefighters from the environmental health hazards experienced during an emergency response; however, more effective firefighting suppression tactics, PPE compliance, and post-decontamination procedures may reduce these exposures.

A strong safety culture has a direct influence on curbing negative safety behaviors among firefighters during emergency responses. Only fire department leaders can drive and develop safety cultures. Thus, leaders who make safety a priority and PPE compliance the expectation influence positive safety behavior outcomes. Training and education on environmental health hazards experienced during emergency responses would give firefighters the necessary information to make better choices and determine appropriate decontamination procedures to

reduce exposures. Ensuring that firefighters have proper training on safety instruments used to determine the use of personal protection equipment, such as air gas monitors, is critical in protecting personnel from environmental health hazards. Providing firefighters with the support and tools necessary to make positive safety choices may lead them to take proactive measures to reduce environmental health exposures from emergency responses.

This study provided insight into firefighter perceptions of environmental health hazards during emergency responses and how these perceptions influenced decisions on personal protection. Safety perceptions are important to protect firefighters from the dangers faced during emergency responses. The significance of this study is that it identified areas that develop firefighter safety perceptions. Fire department leaders may target these areas in developing safety policies and training programs to improve firefighters' perceptions. In doing so, leaders can influence positive safety behavior and equip firefighters with the awareness of hazards to better protect themselves during emergency responses.

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