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# Fire Training Fatalities and Firefighter Adherence to National fire Protection Association Standards

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*Walden University*

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# Walden University

College of Social and Behavioral Sciences

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Walden University  
2018

Abstract

Fire Training Fatalities and Firefighter Adherence to National Fire Protection

Association Standards

by

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MS, Sam Houston State University, 2008

BS, Texas A&M University, 2006

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Public Policy and Public Administration – Emergency Management

Walden University

December 2018

## Abstract

Sudden cardiac arrest continues to be a major cause of firefighter deaths during training due to a lack of individual firefighter adherence to National Fire Protection Association (NFPA) standards. These standards identify requirements for fire departments to create and maintain fitness programs. Existing research has not identified any relationships between training fatalities and individual firefighter adherence to NFPA 1583, Standard on Health-Related Fitness Programs for Fire Department Members. Using self-determination theory as the foundation, the purpose of this cross-sectional correlation study was to investigate whether individual firefighter adherence to NFPA 1583 has a measurable effect on training fatalities. Survey data were collected from 441 paid firefighters from 7 fire departments located in a rural county in a southern U.S. state. Data were analyzed using multiple linear regression. Results indicated that adherence to NFPA 1583 has a statistically significant relationship with reduced firefighter training fatalities ( $p = .000$ ). Recommendations include examining adherence policies to all elements of the NFPA 1583 standard, not just chapters 5 through 8 in the publication. These include chapter 1 administration, chapter 2 referenced publications, chapter 3 definitions, and chapter 4 program organization specifications. The study results may be used by fire department training divisions to improve the health and safety of firefighters.

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## Dedication

This work is dedicated to Rosalie B. Garcia. This one's for you.

## Acknowledgements

This work would not have been completed without the help of several people. I would first like to thank my mom and dad. Without you, the hardest part of this journey would have held up this work. Thank you, Dr. Gary Kelsey, for your undivided support since we first met at National Harbor in the winter of 2014. You possess a human quality in mentorship that is absent in many others. I will never forget the support you have provided as my chair. I would like to thank Dr. Christina Spoons for agreeing to be my second committee member by ensuring that my statistics and methodology were in alignment throughout. Our phone conversations provided the necessary support needed and your experience as a firefighter helped me understand key components to this research. Thank you, Donna Christy, for starting and ending this program with me. I cannot thank you enough for the help and support you have provided as a fellow classmate and a dear friend. Thanks for not giving up on me. I could not have done this without you. Thank you, Courtney Coe, for being my dissertation friend and editor in some instances. Your guidance on some topics, phone conversations, and insight on this journey allowed me to climb the mountain one step at a time. You will remain a vital influence in this endeavor. Finally, thank you, to all the professional firefighters that participated in this research as we collaborate to positively influence the health and wellness of firefighters throughout.

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## Chapter 1: Introduction to the Study

### **Introduction**

Cardiac arrest is the number one killer of professional firefighters. Sudden cardiac death (SCD) accounts for nearly half of fatalities on the job among United States firefighters (Yang et al., 2013). There are some tasks required of firefighters on duty that contribute to testing a firefighter's cardiac health and wellbeing. Personal protective equipment (PPE) worn by personnel comprises one of the first fitness evaluations for firefighters because of the weight and design of the material used on the fire ground. Essentially, PPE provides an element of safety from possible hazards and dangers that firefighters may encounter on duty (Eyre, Hick, & Thorne, 2015). PPE is labeled as structural firefighting protective clothing and must be worn by all firefighters as outlined in standard operating procedures (SOPs). The donning of PPE to be used and worn throughout the emergency is half of the task while the other requirement is performing the duty that is needed during the mitigation efforts. Some of the functions required of fire personnel include fire attack, search and rescue, exterior ventilation, and rapid intervention operations. Performing these tasks while wearing full protective clothing can test the physical fitness levels of most firefighters. Fire activity functions create stresses on the cardiac outputs of each firefighter performing a set of tasks.

Fire department training divisions are responsible for the preparation and efficient execution of fire ground tactics required of today's professional firefighters. According to Poplin, Roe, Burgess, Peate, and Harris (2016), "The need for regularly simulating (training) job tasks within a range of 60-95% of one's maximum capacity was identified to ensure optimal readiness" (p. 251). Some of the activities required for professional

firefighter training include water supply operations, search and rescue scenarios, confined space technical skill situations, along with other team evolutions such as external ventilation. In addition to these, live fire training operations are a requirement in most paid fire departments in the United States. Live fire training evolutions are designed to simulate all the necessary tasks that are commonly required during a real fire situation. These trainings are highly dependent on the physical capabilities of fire personnel during evolutions.

I provided background information on the intricacies of what is required in a fire training scenario that is pertinent to this study. In this background section, a scenario outlining the procedures and realistic participation of fire ground tactics was explored and detailed. The setting is the same environment that the identified population participated in and was described in more detail in Chapter 3. In addition to a brief scenario involving fire ground training operations, a section on NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members* was introduced. This standard is vital to understanding the relationships that are outlined and explored later in this document. Lastly, the background section described firefighter fitness and the importance of maintaining fitness levels for health and wellness coupled with fire ground optimal performance expectations.

The problem statement follows the background sections highlighting the persistent concern of firefighter fatalities during training evolutions. The NFPA 1583 standard was mentioned and the introduction of an adherence policy concern was presented. The purpose of the study is next introduced on how it will investigate individual firefighter adherence to elements of NFPA 1583 and its relationship to training

fatalities. The main research question was next identified along with the null hypothesis and alternative hypothesis for this study. The theoretical framework used for this study was self-determination theory. That section then identified individual motivation components and how they were investigated for this study. These individual components were critical to understanding some of the adherence variables measured among professional firefighting personnel. Some of the characteristics explored and measured in this quantitative study measured motivation variables as they relate to individual firefighter adherence to elements of the NFPA 1583 standard. The nature of the study section follows and the justification for a quantitative statistical method is supported.

A definition of terms section follows the theoretical framework sections and illustrates some of the terminology that is included in the fire service. Assumptions to the study follow the fire service definitions identifying the voluntary participation of the survey instrument along with a reason why firefighters may not complete the surveys due to emergency response obligations in the middle of the research participation. Scope, delimitations, and limitations follow the assumptions section which identified the location of the study and how the results may not be generalizable. The final section in chapter 1 is the significance to the study. In this section, the researcher described the social implications of the study and the overall goal of conducting the research.

## **Background**

### **Scenario**

A mid-morning regular alarm tones out on November 17, 2017 in a town along the Rio Grande River that indicated a confirmed structure fire in progress. Dispatch has provided basic information to the responding units that included one victim on the 2<sup>nd</sup>



floor of the residence. The first incoming unit arrived and provided a scene size-up to the rest of the units to speed up preparations for other assignments. The fire company officer on Engine 7 indicated that there was visible smoke and fire coming from the A-D corner of the structure on the first floor. A 360-degree size-up was quickly conducted by the Engine 7 lieutenant as the crew members deployed a fire attack line, donned their masks, and turned on their air bottles. The first sector captain arrived on scene and assumed command of the incident as the Incident Commander or IC.

It was determined that Engine 7 would initiate rescue operations for a possible victim on the second floor as indicated by the dispatching agency. As a crew in full PPE, Engine 7 advanced a charged fire attack line into the structure and made their way to the second floor. The interior of the structure is identified as an Immediately Dangerous to Life and Health (IDLH) type of environment. It was decided that a left-hand search would be conducted until a possible victim was located. In a short time, the victim was found and carried to safety from the second floor down through the interior of the residence and out to a safe zone.

Engine 5 was the second incoming unit to arrive on scene. The primary task for this company was to coordinate with the driver/operator of Engine 7 and establish a water supply. The hydrant directly in front of the residence was out of play due to a malfunctioning operating nut. The nearest hydrant was located two hundred feet away. This laborious assignment was quickly executed so that the next task at hand could be safely initiated. This task was completed within a short time and provided no interruption of water flow from any of the attack lines. The Engine 5 lieutenant and

firefighters made entry into the structure and advanced a line to the seat of the fire in the room in question. The fire was quickly extinguished.

Rescue 1 arrived on scene as the water supply efforts were in progress. Immediately, the IC ordered this crew to become the Rapid Intervention Team (RIT). The job that this team serves is critical and is only deployed into the structure to assist and rescue fallen firefighters should the interior teams encounter any dangers or difficulties.

Engine 2 arrived within seconds of the third company on scene. The IC gave the order for vertical ventilation at the top of the structure to assist in the fire suppression efforts. This team, also in full PPE set up an extension ladder, made their way to a location directly above the seat of the fire and began ventilation cuts on the roof. The roof was ventilated quickly and the lieutenant on Engine 2 radioed the completion of this task to the IC.

At this point, the victim was rescued and carried to a safe zone, the fire attack efforts ceased, ventilation was provided and RIT ensured the safety of all crews entering the structure. This emergency was quickly mitigated and the IC terminated command. The hoses were put away, and everyone doffed their PPE to allow their bodies to cool down to normal temperatures.

The regular alarm was complete and toned out three additional times after this incident was over. This scenario was an annual training exercise that is required in that fire department. No live victims were used and all operating procedures were conducted as outlined in the National Fire Protection Association (NFPA) Standard 1403, *Standard on Live Fire Training Evolutions*. Each fire company within the city was required to go

through this live fire training scenario and maintain a different role in each evolution (i.e. rescue, fire attack, RIT, external vertical ventilation).

Each of the tasks involved in these training evolutions required a substantial amount of physical capacity and stamina. Physically taxing activities performed by firefighters may include hauling hose, using heavy equipment, or lifting and transporting patients (Jahnke et al., 2015). Crew members have a job of advancing a heavy hose line through a building, carrying a victim to safety, and operating an assortment of other ground tactics that are essential to a smooth operation of fire suppression activities.

It should be mentioned that firefighter training is not limited to live fire training scenarios. Vehicle extrication is an area that utilizes heavy equipment to gain access to possible victims during a vehicle collision. The upper body strength of the firefighter must be enough to operate some of today's equipment for extended periods. These operations are also conducted while wearing full PPE on scene. Many firefighters also provide emergency medical services to the clientele that they serve which can also require physical strength and endurance. Patients may need to be moved or carried in addition to providing cardiopulmonary resuscitation (CPR). Lastly, those assigned to special operations are trained in tactical response that requires sophisticated skills during confined spaces and possible hazardous condition environments. It is imperative that the firefighter is in relatively good shape for these situations.

### **NFPA 1583**

National Fire Protection Association codes and standards written and adopted by municipalities are designed to reduce the potential of harmful effects of fire and other related dangers (NFPA, 2017). The NFPA's code development process is open and

consensus-based and knowledge is contributed to these standards by more than 250 Technical Committees comprising approximately 8,000 volunteers (NFPA, 2017). NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members* has its origins in Chicago, Illinois in the year 1996. This standard was not ready for official publication until June, 1997. NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members* was first issued in the year 2000. Before the development of NFPA 1583, its predecessor NFPA 1582, *Standard on Medical Requirements for Fire Fighters and Information for Fire Department Physicians* was developed in the year 1992.

In this study, I investigated several elements that contribute to the NFPA 1583 standard. Chapter 5, Health and Fitness Coordinator and Peer Fitness Trainers is the first section of exploration and it mentions the significance of maintaining a health and fitness coordinator (HFC) who dictates to a group of peer fitness trainers to carry out all necessary health and wellness tasks for individual firefighters. This HFC also works closely with the department head and all medical staff associated with health and wellness within the fire department. Chapter 6, Fitness Assessment outlines the necessary steps to implement and operate an individual firefighter assessment program within the organization. It is up to the HFC, and peer trainers to carry out the tasks so that the firefighters can safely participate in an individual fitness assessment as required for the physical responsibilities within the organization. Chapter 7, Exercise and Fitness Training Program provides a basic overview of providing the necessary and pertinent areas of individual fitness programming for each firefighter. The specific exercises, routines, and customization of individual workouts are described in this element of the

standard. Chapter 8, Health Promotion Education is an element that outlines the importance of health and wellness promotion within fire departments. This section identifies components that are separate from individual fitness instruction in the form of educational seminars and supplemental information documents. Injury prevention, cardiovascular disease, stresses of the job, accidents, overall health lifestyle habits, and fatalities are topics that can be explored with each firefighter in the fire department. Chapter 2 will detail these elements of NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members*.

### **Firefighter Fitness**

Physical demands of the fire service rely on the physical operability of the professional firefighter to perform a set of tasks safely. The execution of some of the most demanding fire ground objectives remains critically important for the person wearing the proper PPE to function efficiently and effectively. Fire training evolutions are provided for individual firefighters to gain confidence in their abilities to perform a set of tasks that are demanded of them. Additionally, professional firefighters are also required to uphold their own individual physical fitness responsibilities. Argued by Winter, Seals, Martin, and Russell (2010), physical fitness participation should be made mandatory. Additionally, the fire department should “allow for on-duty-time participation utilizing facilities provided by the department; provide for rehabilitation and remedial support for those in need, and contain training and education components” (p. 235). Little evidence exists to support the effectiveness of individual firefighter fitness programs (Gnacinski et al., 2015).

The fact that some programs are not implemented or made mandatory remains to be investigated. It is the individual firefighter adherence to NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members* that shall be the subject of this research. According to Gnacinski et al., (2015), “to reduce the rates of fatality, injury, and workplace stress, organizations such as the National Fire Protection Association (NFPA) have proposed that physical fitness programs be implemented into fire training and safety programs” (p. 342). The stresses of the job do not become less over time and do not disappear from the job description of the professional firefighter. The demands of the fire service have proven to become more complex and continue to present harmful situations to the nation’s 1.3 million firefighters (Spoons, 2012).

### **Adherence**

Professional firefighters encounter real fire in dangerous emergencies every day. The PPE worn by firefighters, equipment used on the fire ground, and fire hoses used to extinguish the fires all are subject to soot and ash and other contaminants. It is expected that firefighters clean the tools and equipment used during emergencies, ensure their operability for the next call, and store these tools in a safe compartment so that their use will not be compromised in the future. Additionally, the firefighter is responsible for cleaning his or her personal protective equipment that was worn during these described emergencies. Fire departments are aware of the dangers of carcinogens exposed to firefighters and gear that does not receive a cleaning treatment is harboring these carcinogens on their equipment and could potentially cause harm to the firefighter.

Fire department SOPs state that the firefighter shall ensure that equipment be returned to optimal operating conditions as well as clean their PPE and bathe to rid their

skin of any harmful chemicals and exposures during emergencies. Harrison et al. (2018) argued that the most consistent decontamination practice after a fire is showering, however only 10% of firefighters report that they rarely or never shower after a fire (p. 283). It may be included in a fire department's operating procedures, but it is clearly not adhered to completely. In fact, 90% of firefighters do not shower after a fire, despite the written policy indicating proper decontamination procedures (Harrison et al., 2018). These policies are part of everyday operations; however, these policies are not universally implemented.

In this study I investigated the level to which individual firefighters adhere to set health and fitness guidelines by their department's administration to help reduce the dangers of fire ground operations. In short, social change will be positively affected among firefighters in the United States by reducing injury and fatalities. Fire department training divisions will be provided the opportunity to examine this study as it investigates individual firefighter adherence to elements of NFPA 1583 and its relationship to training fatalities.

### **Problem Statement**

Firefighter fatalities remain a significant concern for personnel in the fire service. A common goal for both firefighter personnel and administrators is to investigate this ongoing dilemma and try to alleviate the number of firefighter deaths. Firefighters encounter many harmful situations that may impact their health and wellness. Smith (2011) reported that firefighters are faced with a dangerous set of circumstances. These challenging situations include harmful fumes, dangerous by-products of incomplete combustion, high heat environments, and daily challenges on the job (Smith, 2011). The

firefighter is protected by these hazardous conditions by utilizing PPE. Training for these firefighters is constantly provided so that personnel are accustomed to operating under most conditions while wearing PPE.

Chaotic work environments during training exercises can encompass several elements that challenge the senses of a firefighter such as sight, sound, and touch. Training evolutions are designed and executed to help create comfort in the most uncomfortable situations such as zero visibility conditions, high decibels of sound, and obstacles of disorientation to help a firefighter self-rescue themselves during times of danger. These training scenarios rely heavily on an individual firefighter's physical fitness and conditioning to carry out the necessary tasks during fire ground operations. Concerns for firefighter fatalities are alarming when these events happen in training environments designed to develop high quality firefighting skills. NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members*, is a national consensus standard that outlines health and wellness programs for firefighter personnel. After the publication of this standard, firefighters still face death during training. Adherence elements of this standard were investigated among individual paid firefighters.

### **Purpose of the Study**

The intent of this quantitative study was to investigate individual firefighter adherence to elements of NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members* and its relationship to training fatalities. I surveyed 441 paid firefighters in a rural county in a southern U.S. state regarding their knowledge and implementation of NFPA 1583. The purpose of this study is to illustrate



any significance to the lack of adherence by individual firefighters to fitness policies and analyze the relationship between NFPA 1583 and firefighter training fatalities.

I measured independent and dependent variables to display any relationships in the research question. Covariate variables were introduced to investigate any additional motivators that may or may not have contributed to additional relationships between the outcome and predictor variables. The collection of all data measured provided an answer to the research question. The survey consisted of four dependent continuous outcome variables and 11 independent predictor variables, and three independent ordinal variables. Additionally, the two covariates are continuous and are divided into individual intrinsic and individual extrinsic categories. The 11 independent variables are *yes/no* and *yes/no/I don't know* type questions while the four dependent and two covariate variables are *continuous* and *scale*. Lastly, the three independent ordinal variables target demographic information included to examine other relationships in the research. A description and table illustrating each variable is presented in Chapter 3.

### **Research Question**

The foundational study research question was: What factors are associated with the degree of individual firefighter adherence to elements of NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members* while controlling for motivation?

$H_0$ : After controlling for motivation, there are no differences in the degree of individual firefighter adherence to elements of NFPA 1583.

$H_1$ : After controlling for motivation, there are differences in the degree of individual firefighter adherence to elements of NFPA 1583.

## **Theoretical Framework**

Firefighters that participate in physical fitness are either mandated by standard operating procedures (SOPs) or are individually motivated to complete the requirement as part of their job duties. It is essential for professional firefighters to maintain set levels of physical fitness to perform the required duties asked of them. Self-determination theory was the theoretical framework for the research as it measured fitness adherence through individual motivation of each firefighter. As mentioned by Deci and Ryan (2008), work motivation was the driving force for individual's productivity on the job. Additionally, self-determination theory is an idea about motivation that contributes to a further understanding of self-growth (motivation) as it strives for psychological needs (Deci & Ryan, 2000, 2002).

### **Motivation components**

Self-determination can be further understood by examining some of the contributing constructs of this ideology. As mentioned by Deci and Ryan (2000), autonomy, competence, and relatedness are components of basic psychological needs. These are essential during the investigation of understanding both internal and external motivators as they contribute to optimal health (Deci & Ryan, 1985; Ryan & Deci, 2000).

Autonomous orientation is one of the most central of all psychological needs in the sense of research; autonomy refers to behavior that is self-endorsed. When a person is fully autonomous, performance tends to be better when that person is acting out of autonomous motives (Deci & Ryan, 1985). As we will see in Chapter 2, this theory of self-determination is applicable to this study due to its highlighting importance of psychological need fulfillment for optimum firefighter fitness health and wellness.

Motivation in this study is relatively simple—to reduce the likelihood of death due to fitness preparedness. Deci and Ryan (1985) argued that most contemporary theories of motivation assume that people initiate and persist at behaviors to the extent that they believe the behaviors will lead to desired outcomes or goals (p. 227). In this case, a desired goal is to prolong the individual health and wellness of the career of a professional firefighter. It is through this exploration of some individual motivation components that the researcher was able to identify why fitness policies are executed and are not executed by members of the fire service. This contributed to a further understanding of the level of individual firefighter adherence to elements of NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members*. Chapter 2 provides a detailed explanation of self-determination theory and its suited application for this study.

### **Nature of the Study**

Exploration of this topic and the research question is well suited to a quantitative data-gathering approach. According to Creswell (2009), scientists observe relationships of variables in a quantitative study. The objective of identifying and then later manipulating data in SPSS software is directly related to having a purposeful and quantitative research design. A survey allowed the study to reach a large population in a relatively short time. Independent and dependent variables were measured to display any relationships in the research question. Covariate variables were introduced to investigate any individual motivators that may or may not contribute to additional relationships between the outcome and predictor variables. Also, several demographic variables assisted in understanding and illustrated other relationships. The collection of all data

measured provided an answer to the research question. The survey consisted of four dependent continuous outcome variables and 11 independent predictor variables. Additionally, the two covariates are continuous and are divided into intrinsic and extrinsic individual motivation categories. The independent variables are *yes/no* and *yes/no/I don't know* type questions while the dependent and covariate variables are *continuous* and *scale*. The survey included three demographic ordinal variables and are located at the end of the survey. A description and table illustrating each variable is presented in Chapter 3.

The results were electronically collected by the online survey company SurveyMonkey. This type of methodology is in alignment by investigating the research question. Possible types and sources of information or data: surveys completed by paid firefighters.

### **Definition of Terms**

*Attack line:* Hose that is used by trained firefighters to combat fires (Stowell & Murnane, 2013).

*Autonomy orientation:* Comprised of self-regulated actions driven by the intrinsic value of a situation, originated from experience to fulfill self-determined outcomes (Deci & Ryan, 1985).

*Command:* Established by the first-arriving officer with expected actions such as: establishing command, making the initial size-up, deploying available resources, communicating the situation to the communication center and other responding units (Stowell & Murnane, 2013).

*Company:* A basic unit of firefighting operations, which is commanded by a company officer and typically includes a driver/operator or engineer, firefighter, and emergency medical technician (Stowell & Murnane, 2013).

*Control orientation:* Comprised of self-regulated actions driven by intrinsic and extrinsic value to a situation, originated from experience to fulfill self-determined outcomes (Deci & Ryan, 1985).

*Doff:* To take off an item of clothing or equipment (Jones & Bartlett, 2008).

*Don:* To put on an item of clothing or equipment (Jones & Bartlett, 2008).

*Engine company:* Performs fire suppression duties at structure, vehicle, wildland, and other fires, such as providing a water supply and advancing attack hose lines (Stowell & Murnane, 2013).

*Immediately Dangerous to Life and Health (IDLH):* Description of an atmosphere that poses an immediate hazard to life or produces immediate, irreversible, debilitating effects on health (Stowell & Murnane, 2013).

*Impersonal orientation:* Self-regulated actions driven by the lack of intrinsic and extrinsic value to a situation originating from experience that will prevent self-determined behavior (Ortlieb, 2013).

*Incident commander:* Person taking responsibility for all on-scene operations, known as the IC. The first officer on scene assumes this responsibility, and the higher-ranking officer may take over the scene if deemed appropriate, but does not need to (Stowell & Murnane, 2013).

*Personal Protective Equipment (PPE):* General term for the equipment worn by fire and emergency services responders; includes helmets, coats, trousers, boots, eye

protection, hearing protection, protective gloves, protective hoods, self-contained breathing apparatus (SCBA), and personal alert safety system (PASS) devices (Stowell & Murnane, 2013).

*Rapid Intervention Crew or Team (RIC/RIT):* Two or more firefighters designated to perform firefighter rescue; they are stationed outside the hazard and must be standing by throughout the incident (Stowell & Murnane, 2013).

*Rescue company:* Searches for and removes victims from areas of danger or entrapment and may perform technical rescues (Stowell & Murnane, 2013).

*Self-determined behavior:* An individual has self-regulated actions through a point of control, derived from previous experiences that seek to promote motivation (self-growth) by satisfying the basic psychological needs of autonomy, competence, and relatedness (Deci & Ryan, 1985; Ortlieb, 2013)

*Size-up:* Ongoing evaluation of influential factors at the scene (Stowell & Murnane, 2013).

*Vertical ventilation:* Ventilating at a point above the fire through existing or created openings and channeling the containment atmosphere vertically within the structure and out the top (Stowell & Murnane, 2013).

### **Assumptions**

The assumptions of this study included that response to the fitness survey was voluntary and that individual firefighters would not feel persuaded or pressured in any way to participate in the research. A second assumption indicated that those firefighters that chose to participate provided honest answers about individual firefighter training, individual firefighter fitness motivation, individual firefighter fitness responsibilities, the

importance of fitness, and their views on health and wellness. Each firefighter also answered adherence questions about NFPA 1583. The nature of the fire service and its members fosters an environment of constant interruption by responding to emergencies that may arise at any given time. Additionally, an assumption on this interruption of participation for the survey should not hinder the reliability and validity of this fitness survey. The statistical assumptions of this research relate to the use of a statistical multiple regression model and that the variables in this study are measurable, quantifiable, reliable, are distributed normally, and display a linear relationship (Creswell, 2009; Warner, 2013).

### **Scope, Delimitations, and Limitations**

#### **Scope**

This research was intended for the investigation of individual paid firefighters in the southern United States. The scope of the training fatality cases included all instances that occurred since NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members* was first published in 2000. The researcher did not incorporate findings of fatalities that took place before or after the training event, such as on the way back to the station or in a designated fire apparatus unit. Chapter 2 identified each case that was pertinent to the study in the literature review.

#### **Delimitations**

The National Fire Protection Association (2017) reported that the United States is comprised of 29,727 fire departments and 345,600 paid professional firefighters. This study focused on paid firefighters from seven paid fire departments that serve a rural county in a southern U.S. state. I attempted to investigate this specific sample

designation because 345,600 may be too large for this study. Other categories of fire departments include: mostly career, mostly volunteer, and all volunteer (NFPA, 2017). Future studies may examine these other categories along with different population sizes.

### **Limitations**

The researcher did not identify who did and did not participate in this study to maintain complete anonymity of the research. The focus of this research was to target seven fire departments that serve municipalities in a rural county in a southern U.S. state. The total number of participants in this study was 441. This number is not representative of the entire population of professional firefighters that work in the remaining counties in that U.S. state and in the other 49 states nationwide. Due to this limitation, the implications were not generalizable to the entire fire service. Alternatively, future studies can be conducted for fire departments that serve much larger populations.

### **Significance of the Study**

This topic examined the health and wellness programs of individual professional firefighters in the United States. The potential for other departments to follow fitness programs as outlined in NFPA 1583 is considerable. The individual firefighter adherence to NFPA 1583 was investigated and correlated with any fatalities that have occurred since the document was first published. Cardiovascular issues are the number one cause of fatalities among fire personnel, especially during live fire emergency operations. The magnitude of work involved during these events can cause damaging effects for those personnel that are not physically conditioned. These effects also apply to individuals who do not adhere to a wellness policy in their organization's Standard Operating Procedures (SOPs). Fire department training divisions are responsible for providing



training to help enhance the performance and work productivity of individual firefighters. Additionally, following guidelines and fitness programs as outlined in NFPA 1583 should make positive social changes in the health and wellness of professional firefighters.

In this study, I investigated the level to which individual firefighters adhere to health and fitness guidelines to help reduce the dangers of fire ground operations. Saving lives on the fire ground remain a number one priority in the fire service. In short, social change will be positively affected among firefighters in the United States by reducing injury and fatalities. Further studies can examine related issues on this subject by conducting investigations on other variables. Fire department training divisions will be provided the opportunity to examine this study as it investigates the relationship between individual firefighter adherence to NFPA 1583 and firefighter training fatalities.

### **Summary**

Firefighter training fatalities remains a concern for fire department personnel in the United States. Firefighters that do not participate in regular physical training and conditioning are at risk for potential loss of life during training and real scenarios that require physical work (Smith, 2011). Chapter 1 documented the importance of individual physical conditioning, individual fire ground training, and rationale for the study. The purpose of this quantitative study is to investigate individual firefighter adherence to elements of NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members* and its relationship to training fatalities. Chapter 2 incorporates a review of the literature as it relates to the study. Chapter 3 documents the quantitative design to address the research question along with the sample size used, the data collected, and analysis performed. Quantitative data collected was analyzed and was

presented in Chapter 4. Chapter 5 contains a section on implications for social change, conclusions from the research, recommendations for future studies, and summary.

## Chapter 2: Literature Review

### Introduction

Firefighter fatalities are a concern worthy of much needed attention. Firefighters encounter many harmful situations that may impact their health and wellness. Smith (2011) argued that firefighters are faced with a dangerous set of circumstances. These challenging situations include harmful fumes, dangerous by-products of incomplete combustion, high heat environments, and daily challenges on the job (Smith, 2011). Firefighters combat these environments and conditions by training regularly to become proficient in emergency response tactics and skills.

These training scenarios rely heavily on an individual firefighter's physical fitness and conditioning to carry out the necessary tasks during fire ground operations. Concerns for firefighter fatalities are alarming when these events happen in training environments designed to develop high quality firefighting skills. NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members*, is a national consensus standard that outlines health and wellness programs for individual firefighters. Since the publication of this standard, firefighters have still faced death during training. Individual firefighter adherence to elements of this standard is not well understood and was investigated among paid firefighting personnel.

The purpose of this quantitative study was to investigate individual firefighter adherence to elements of NFPA 1583 and its relationship to training fatalities while also controlling for motivation. I surveyed 441 paid firefighters in a rural county in a southern U.S. state regarding their knowledge and implementation of NFPA 1583. Evidence is limited to support the effectiveness of firefighter fitness programs (Gnacinki et al., 2015).

This chapter includes a review of the literature on

1. Literature Search Strategy
2. Theoretical Framework - Self-Determination theory
3. Literature Review Related Key Variables and Concepts
4. Consensus Standards
5. Development of NFPA 1583
6. Elements of NFPA 1583
7. Adherence to NFPA Standards
8. NIOSH Investigations
9. Firefighter Training Fatalities Since 2000
10. Summary

The literature review included studies that have illustrated the dangers of the fire service as it pertained to the importance of being fit for duty. Individual firefighter fitness has been investigated due to statistics that indicate a high occurrence of cardiac arrest fatalities. Sudden cardiac deaths experienced by firefighters account for the largest proportion of deaths annually (Storer et al., 2014).

### **Literature Search Strategy**

A primary search was conducted through the Walden University Thoreau Multi-Database Search tool. The results from the initial searches did not pertain to fire training fatalities. Rather, there is significant literature on live fire fatalities, which is labeled as a line of duty death (LODD). SAGE Journals (formerly SAGE Premier) was another database that provided research direction to the study. Other databases used as sources of the literature included:

1. EBSCO Databases
2. Academic Search Complete
3. Dissertation & Theses @ Walden University
4. Homeland Security Digital Library
5. Political Science Complete
6. ProQuest Dissertations & Theses Global
7. ProQuest Science Journals.

The databases were used by incorporating more specific search criteria that included: *Firefighter training*, *Firefighter training fatalities*, *firefighter fatalities*, *NFPA 1583*, *firefighter fitness*, *adherence to fitness policies*, and *self-determination theory*.

I also searched for information utilizing the same keywords on National Fire Protection Association (NFPA), National Institute for Occupational Safety and Health (NIOSH), U.S. Fire Administration (USFA), and Federal Emergency Management Agency (FEMA) through the U.S. Department of Homeland Security web sites. After a manual and electronic search, the related literature is best presented under the sections that follow. The literature was divided into sections: the theoretical framework for the study, literature review related to key variables and concepts, consensus standards, development of NFPA 1583, elements of NFPA 1583, adherence to NFPA standards, NIOSH investigations, and firefighter training fatalities since 2000. Literature cited in this study was published within the last six years so that the information supports current published and peer-reviewed findings.

### **Theoretical Framework**

Deci and Ryan (1985) presented a self-determination theory that emphasized concepts of individual motivation as they pertained to psychological needs and an application for optimum health and wellness. Autonomy (control over one's behavior), competence (self-growth), and relatedness (purpose in a social setting) contribute to an understanding of psychological needs (Deci & Ryan, 2000). Autonomy refers to behavior that is self-endorsed or motivation from within. When a person is fully autonomous, performance has been shown to be improved when that person is acting out of autonomous motives (Deci & Ryan, 1985). These components of self-determination theory are critical to understanding internal and external individual motivators as they are used to investigate health and wellness (Deci & Ryan, 1985; Ryan & Deci, 2000).

This study is guided by several principles of self-determination. Deci and Ryan (1985) suggested that the psychological needs for autonomy, competence, and relatedness are essential for optimum physical health and well-being. Boyd (2016) reported that environments that are autonomy supportive provide an individual with choices resulting in autonomy rather than controlled behavior (p. 30). Lastly, fulfillment of the psychological needs for autonomy, competence, and relatedness promote autonomous motivation (Deci & Ryan, 1985, 2000; Ryan & Deci, 2000).

Individual motivation is a component to this study as it relates to adherence to a fitness and wellness policy among firefighting personnel. Self-determination theory examines two types of motivation: intrinsic motivation, displaying a natural and essential level of self-enjoyment and extrinsic motivation prompted by outcomes outside of self (Ryan & Deci, 2000). Extrinsic motivation can be broken down further by mentioning

two additional components: controlled and autonomous motivation (Deci & Ryan, 1985; Ryan & Deci, 2000). Controlled motivation is centered on a social environment, or by self-imposed feelings. Autonomous motivation amplified by self-awareness and recognition of the benefit or value of certain activities results in better performance for well-being and engagement (Deci & Ryan, 2000).

Deci and Ryan (1985), mentioned in self-determination theory that people maintain individual growth ideology as it has evolved into a self-growth principle. Motivation from within an individual's self-growth is vital to understanding this study. Individual firefighters that engage in regular physical activity to satisfy training requirements maintain certain levels of self-motivation or self-growth. "It is the continual struggle of individual self-growth and the variables associated with the growth that has driven the self-determination theory in research" (Ortlieb, 2013, p. 59).

In an argument on social interactions and self-growth, Deci and Ryan (2000) mentioned that not all interactions promote self-growth and in some instances, social interactions prevent such growth. This can be particularly important in the third component, relatedness. In a social setting, an individual's purpose can be distinguished into intrinsic or extrinsic designations depending on the relatedness aspect of motivation in the individual.

Self-determination theory is rooted heavily in the literature because of its application on other theories and subtheories. The general understanding of self-determination supports autonomy, competence, and relatedness as components of motivation to help further understand and investigate health-related behaviors (Boyd, 2016). Researchers have incorporated self-determination theory to study other

components of motivation such as personal striving, physical activity, adaptation to life changes, and injury recuperation (Deci & Ryan, 2008; Graves & Luciano, 2013; Hein & Caune, 2014; Hill & Pettit, 2013; Podlog et al., 2011). Self-determination theory is applicable for individual firefighter motivation exploration in health and wellness fulfillment.

Firefighters carry out tasks individually or as an entire company to include engine companies, truck companies, special operations companies, and rescue companies. This participation can be viewed and supported through the autonomy components of self-determination theory or SDT. Long, Readdy, and Raabe (2014) supported the application of SDT in a variety of exercise contexts and has been shown to be theoretically relevant of whether SDT can help provide an understanding of exercise behavior in firefighters (pp. 205-206).

### **Literature Review Related to Key Variables and Concepts**

It is essential that each firefighter maintain an appropriate amount of fitness so that basic job requirements are met daily. A firefighter is responsible for utilizing the appropriate PPE. In most cases, full PPE can weigh up to seventy pounds. The task of wearing this gear is amplified when the job requires extensive physical work on the fire ground.

### **The Science of Firefighter Fitness**

Training evolutions are designed so that an individual firefighter can create and establish proficiency in an assortment of fire ground tactics. The intent is to become comfortable while operating under the physical demands of PPE and job task assignments. The career of firefighting incorporates a wide variety of hazards (Smith,



Barr, & Kales, 2013). To this, the importance of physical fitness cannot be stressed enough. An individual firefighter must be responsible for maintaining appropriate cardiovascular endurance, strength, stamina, and flexibility to safely operate under most hazardous conditions. Smith et al., (2013) argued that firefighters are regularly required to perform activities combining static and aerobic exertion such as “stair and ladder climbing (while carrying heavy equipment), forcible entry, victim search and rescue, building ventilation, and fire attack and suppression” (p. 3).

Cardiac concerns are at the forefront of firefighter research. Firefighter’s cardiac health research has received less attention than other topics such as cancer, injury and physiologic strain (Jahnke, Poston, Jitnarin, & Haddock, 2012). Cardiovascular disease (CVD) is a topic explored among firefighter health and wellness programs and it is imperative to explore individual adherence to fitness policies to illustrate any relationships between CVD and firefighter fatalities. Studies have been designed to identify on-duty tasks and biological-based risk factors most commonly associated with CVD in firefighters (Delisle, Delisle, Chaney, Stopka, & Northcutt, 2013). The literature supports that physical demands of firefighters remain high and risks associated with CVD are likely to lead to sudden cardiac death (SCD) among firefighters (Delisle et al., 2013). Additionally, physical fitness is correlated with job performance, and fire suppression activities require an above-average fitness capacity (Stanley, Weiner, & Linnan, 2011). Stanley et al., (2011) mentioned that this topic had been extensively researched, “but interventions to improve fitness and coronary health are less frequent” (p. 604).

In comparison to other employment trades that rely heavily on physical work, firefighters are more likely to face injury than other laborers and having a lack of

physical fitness will lead to more risks for injury (Griffin et al., 2016). Individual firefighters are also afforded the opportunity to exercise and maintain physical fitness and conditioning while on duty.

### **Fitness components**

Fitness can be described by five components: (a) cardiovascular fitness, (b) muscular strength, (c) muscular endurance, (d) flexibility, and (e) body composition (American College of Sports Medicine, 2010). In addition to the five fitness components, NFPA 1583 provides fitness guidelines that incorporate measures of aerobic capacity, flexibility, muscular strength and endurance, and body composition testing as part of a regular fitness regimen (Bhojani et al., 2018). The importance of cardiovascular fitness allows an individual firefighter to withstand different physical requirements while performing activities on the fire ground. This is particularly important when an incident extends for long periods of time. Having the proper muscular strength permits the firefighter to operate under conditions that require the use of full PPE attire along with operating heavy equipment that is necessary during mitigation efforts. Muscular endurance enables the firefighter to manipulate certain tools and execute applicable functions that require above average fitness levels. Having the proper flexibility is vital during training operations due to the strenuous requirement of maneuvering certain types of equipment and rescuing a simulated victim within a confined space inside a training facility. Body composition can be medically authorized by body mass indexes. The component of body composition has been identified by percentages of body fat (American College of Sports Medicine, 2010).

## Physiology

Firefighting training evolutions are designed to simulate real scenarios faced by firefighters every day. The physical requirements and activities during training can be equally hazardous to the unconditioned firefighter just as they would in a real fire emergency. Ensari et al., (2016) presented that research interests in firefighter health and safety increase as new hazards have been shown to be harmful to the health and wellness of professional firefighters. Some researchers simulated fire ground operations and studied specific components during training activities to further examine the physiological stresses that are faced by individual firefighters. Best practices for determination of a firefighter's fitness capacity is essential to understand cardiovascular disease, the most common cause of work-related mortality among firefighters (Bhojani, et al., 2018). Ensari et al. examined physiological stresses among firefighters via firefighter activity stations (FAS) that simulated fire ground hazards and other firefighting job stressors. It was under these experiments that scientists analyzed the cardiorespiratory responses, heart rates (HR), core temperatures (TCO), oxygen consumption ( $VO_2$ ), and ventilation ( $V_E$ ) that mimic firefighting activities (p. 658).

The number one cause of United States firefighter fatalities remains sudden cardiac death (SCD) (Yang et al., 2013). Additionally, heavy PPE coupled with strenuous work in dangerous environments add distinctive physical tests on the human body during fire ground operations (Delisle et al., 2013). The unique set of stressors that are encountered during firefighting duties results in physiological cardiovascular strain (Smith, 2011). Simulated trainings have helped create a further understanding of the number one cause of death among firefighting personnel. The United States Fire

Administration reported that most (76%) of fire departments lacked programs to help firefighters maintain their physical fitness (Jahnke et al, 2012). The literature supports the dangers of the physical job requirements for firefighters and the need to further examine fitness protocols.

### **Consensus Standards**

The National Fire Protection Association is viewed as a compilation of consensus standards to be used and adopted by choice in fire departments both domestic and internationally (NFPA 2017). Mohla (2017) reported that standards are a consensus opinion of a group of subject matter experts (SMEs) who document and share their skills with the general users, who may not be experts. Just like the creation of NFPA 1583 after NFPA 1582, this standard was based on the past to provide directions for the future (Mohla, 2017). The same research by Mohla concluded that consensus is a “process for people who want to work together honestly to find good solutions from the group” (p. 71).

It is up to the municipality and fire department to adopt NFPA standards as part of their standard operating procedures (SOPs). Not every component of the standard is a requirement and it can be customizable at the time of its adoption. In their application, these standards have been seen to be effective in reducing the harm of fire and other related hazards as outlined by the association’s mission. Lee et al., (2016) indicated that these standards could be used by research entities to investigate further harmful effects of fire hazards as they related to the health and wellness of firefighting personnel. The expert knowledge that contributes to the design of each standard is immeasurable and helps promote positive social change by their adoption. Health and wellness entities have

utilized consensus standards in a way to investigate guidelines and measurable outcomes in other related patient reporting. NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members* is aimed at improving the health and wellness of individual firefighters.

### **Development of NFPA 1583**

For over one hundred years, the National Fire Protection Association has maintained their mission to lessen the harmful risks of fire and related dangerous exposures (NFPA, 2017). At the turn of the 19<sup>th</sup> century, several committees of individuals came together to help establish the beginning of this organization. It was facilitated by a Massachusetts Institute of Technology civil engineer graduate, John Ripley Freeman. According to NFPA, it was determined that the organization has its origin in the year 1896. John Freeman served as an inspector with Essex Company in which he would spend years revitalizing the organization's approach to fire protection and put it on a truly scientific basis (NFPA, 2017).

NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members* has its origin in Chicago, Illinois in the year 1996. Initially, this standard was not finalized and required special committees to provide necessary revisions in a final draft. The first publication of NFPA 1583 was in the year 2000. Before this publication, NFPA 1582, *Standard on Medical Requirements for Fire Fighters and Information for Fire Department Physicians* was developed in 1992. Essentially, the first standard helps fire departments when hiring recruits, while NFPA 1583 is designed and intended for maintaining health and wellness programs for the existing individual firefighter.

### **Elements of NFPA 1583**

The first publication of NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members* was published in 2000. NFPA (2014) mentioned that “multiple stress factors and rigors require fire fighters to be medically and physically fit to perform required tasks” (p.1). It has been recognized that this standard directly follows NFPA 1582, *Standard on Comprehensive Occupational Medical Program for Fire Departments*. The four elements explored in this study are as follows: Chapter 5 Health and Fitness Coordinator and Peer Fitness Trainers, Chapter 6 Fitness Assessment, Chapter 7 Exercise and Fitness Training Program, and Chapter 8 Health Promotion Education.

#### **NFPA Chapter 5**

Chapter 5, Health and Fitness Coordinator and Peer Fitness Trainers provides the standard with the proper language when a fire department adopts this policy. The fire chief is to determine a health and fitness coordinator (HFC) from within the organization or a third-party representative. The HFC will oversee fitness among individual firefighters and report to the medical physician assigned to oversee the firefighting personnel. One of the assignments of this HFC is to present information of health and wellness to the membership (NFPA, 2014).

Additionally, Chapter 5 indicates that the HFC works in conjunction with peer fitness trainers. The peer fitness trainers “coordinate and oversee safe participation in health-related fitness programs” (p.7). The HFC is also in charge of overseeing the academies that train new fire cadets (NFPA, 2014).

**NFPA 1583 Chapter 6**

Chapter 6, Fitness Assessment is another element investigated in this study. This chapter indicates that the fire department conduct fitness assessments for each firefighter. The assessments can be conducted as many times as deemed appropriate by the health fitness coordinator. The time can range from an annual exam, bi-annually, and quarterly. Not all fire departments implement fitness programs recommended by NFPA 1583, and some fire departments may not have any individual fitness assessments. The physiological categories are also outlined by NFPA 1583 and include “aerobic capacity, body composition, muscular strength, muscular endurance, and flexibility” (NFPA, 2014, p.7).

**NFPA 1583 Chapter 7**

Chapter 7, Exercise and Fitness Training Program identifies required sections maintained within an individual fitness program as outlined in NFPA 1583. A fitness program implements all the necessary components that meet the minimum fitness standards for individual firefighters. The health and fitness coordinator (HFC) is responsible for outlining the following programming components:

1. an educational program that highlights the benefits of exercise on performance and health.
2. Individualized prescription based on the results of the fitness assessment.
3. A warm-up and cool-down guidelines.
4. Aerobic exercise.
5. Muscular resistance.
6. Flexibility exercise.

7. Healthy back exercise.
8. Safety injury prevention programming.

All of these listed items are mentioned in Chapter 7 of the NFPA 1583 standard (NFPA, 2014, p. 8). The programming components help to ensure that each member is afforded a tailored exercise fitness guideline to adopt based on their performance while also addressing a larger fitness membership audience.

### **NFPA 1583 Chapter 8**

Chapter 8, Health Promotion Education provides items that establish and promote the educational components for an individualized health and fitness program within the organization. The chapter also indicates that the organization shall include topics of “health risk reduction, cardiovascular disease reduction, general health maintenance, fitness, and prevention of occupational injuries, illnesses, accidents, or fatalities” (NFPA, 2014, p. 8). The education and materials in the listed topics within the health segment of Chapter 8 shall be provided to individual members that seek the knowledge and instruction on how to live a healthy life and maintain safe and productive job requirements. The social implication within this standard is to continue to raise proactive approaches in individual health and fitness within the fire service. The knowledge obtained by the application of this element within the NFPA 1583 standard will create a safer environment for the professional firefighter while on duty and in training environments.

Many municipalities follow set forth guidelines of NFPA 1582 to hire qualified candidates to their fire academies and departments. It is believed that NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members* is



considered a companion document to NFPA 1582 (NFPA, 2017). NFPA 1582 is a standard that assists administration during the hiring process of its most qualified candidates while NFPA 1583 maintains the individual physical health and wellness of its membership by departments adopting the guidelines written by the standard.

### **Adherence to NFPA Standards**

This study investigated the level of individual firefighter adherence to fitness and wellness policies. The intent of NFPA 1583 is to outline the necessary components for a recommended individualized health and wellness program. Fitness coordinators and specialists have created this consensus standard so that in its application, can help reduce some of the hazards faced by firefighting personnel. Despite the availability of access to guidance on individualized health and wellness programs, more than 73% of fire departments in the United States have no formal wellness or fitness program in place (NFPA, 2016). Storer et al., (2014) identified that studies had revealed the positive effects of wellness programs in a variety of industries, including fire departments, yet there has been little movement to implement wellness programs in the fire service nationwide.

Fire departments indicate in their standard operating procedures (SOPs) that the firefighter shall ensure that equipment be returned to optimal operating conditions as well as clean their PPE and bathe to rid their skin of any harmful chemicals and exposures during emergencies. Harrison et al., (2018) argued that the most consistent decontamination practice after a fire is showering, however only 10% of firefighters report that they rarely or never shower after a fire (p. 283). It may be included in a fire department's operating procedures, but it is clearly not adhered to completely. In fact, it

leads the reader to understand that 90% of firefighters do not shower after a fire, despite the written policy indicating proper decontamination procedures (Harrison et al., 2018). These policies are part of everyday operations however it is the implementation of these policies, or implementation analysis that understands the adherence or lack of adherence to these indicated policies.

Additionally, programs to help health and wellness among firefighting personnel have identified to be less than stellar. MacKinnon et al., (2010) argued that the health profile of career firefighters tends to be poor, with many firefighters having inferior dietary habits and low levels of activity leading to increased risks for multiple lifestyle-related conditions. These lifestyle conditions such as “obesity, diabetes, high cholesterol, coupled with high-stress environments on the fire ground increase a firefighter’s risk for cardiovascular disease and on-duty cardiovascular events” (Staley, Weiner, & Linnan, 2011). NFPA (2016) presented that 73% of fire departments in the United States do not have programs in place to maintain the individualized health and wellness of firefighters.

The importance of firefighter wellness programs has heightened over the last decade. Leffer and Grizzell (2010), argued that a substantial amount fire departments do not participate in health and wellness fitness programs for individual firefighters. The intent of these programs will help eliminate those potential firefighters at risk so that they do not experience a fatal injury while on the job or during training.

### **NIOSH Investigations**

The National Institute for Occupational Safety and Health (NIOSH) is a division within the Centers for Disease Control and Prevention Bureau. These entities operate under the U.S. Department of Health and Human Services. The Occupational Safety and

Health Act of 1970 established NIOSH as a research agency focused on the study of worker safety and health, and empowering employers and workers to create safe and healthy workplaces (NIOSH, 2017). One of the goals of NIOSH is to conduct research to reduce worker illness and injury and to advance worker well-being (NIOSH, 2017). U.S. Congress later appropriated funding for a firefighter safety initiative in 1998 (Spoons, 2012). It was through this initiative that line of duty deaths (LODD) were investigated and documented to help understand why firefighters continue to face serious consequences during fire ground operations.

When a firefighter encounters a serious or fatal injury, the NIOSH Fire Fighter Fatality Investigation and Prevention Program conducts independent investigations (NIOSH, 2017). The procedure for these investigations includes: Step 1 receive notification, Step 2 decide to investigate, Step 3 conduct a site visit to gather information, Step 4 prepare a report, and Step 5 disseminate information. On record, there are 639 completed investigations conducted by the NIOSH Fire Fighter Fatality Investigation and Prevention Program. This study will focus on the incidents that have taken place since NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members* was published.

### **Firefighter Training Fatalities Since 2000**

This section will indicate a review of the fatalities that have taken place since NFPA 1583 was first published in 2000 through 2016. These cases are completed investigations conducted by The National Institute for Occupational Safety and Health (NIOSH). 639 cases are presented by NIOSH that highlight serious injury and deaths. 23 incidents fall within the parameters of this study which include career firefighter

training events that led to a fatality. Occurrences that resulted in a fatality significantly after the training evolution, including more than one day later or during normal physical exercise activities, were excluded from this study. Firefighter fatality information did not include any names or department information in the years 2013, 2014, 2015, and 2016 (FEMA, 2013, 2014, 2015, 2016).

The fatality reports were examined to try and understand why fatalities still occur during training events. As indicated earlier in this document, the intent of a training evolution and training scenario is to create proficiency and add to a skill set for firefighter ground tactic efficiency when mitigating a real-life emergency. The goal is to help develop a firefighter's knowledge and practice the necessary steps to safely combat live fire, hazardous material incident response, medical emergency situations, and other specialized disciplines that require the firefighter to be in a physically able state.

There were no consistent patterns identified in the NIOSH investigation reports. These NIOSH reports extensively reviewed each incident so that the cause of death by the coroner's office and medical forensic physicians could be determined. The time of the day, the weather conditions, the environment that include the facilities were also included in each investigation so that all variables that contributed to a death were investigated. Fire department medical records accessible to certified medical physicians investigating the identified cases were used to determine the specialist's conclusions for the NIOSH reports. In addition to medical records, interviews with the personnel that were with the fallen firefighter were used in the investigations. Some years experienced a higher number of training fatalities while other years did not experience any deaths. The 23 cases examined and used for this study spanned from the years 2000 through 2016 and

22 incidents involved male firefighters and one included a female firefighter. The type of training activities included the following:

1. Structure Fire Drill (no fire)
2. Search and Rescue Training
3. Red Card/Wildland Certification
4. Live Fire Training
5. Pack Test for Wildland Firefighting
6. Endurance Training Utilizing Building Climb Scenarios
7. Endurance Evaluation Training
8. Maze-Training for Lost or Disoriented Firefighters
9. Physical Ability Tests (PAT)

The firefighters that participated in each of the listed areas of training, are accustomed to this assortment of training as outlined in their professional licensing requirements. All of those areas are each tested and approved by a licensing board in order for the firefighter to receive certification and licensing rights. The firefighters were utilizing the appropriate PPE and later collapsed resulting in death during or at the end of the training scenario. The firefighters were pronounced dead by medical staff at a hospital. 15 of the 23 investigations recommended to phase in mandatory fitness programs and one case mentioned to phase in a mandatory wellness program (FEMA, 2003; NIOSH, 2004). NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members* includes wellness as part of the suggested elements of the standard. The remaining recommendations from the medical examiner's reports,

coroner's office, and lead investigators included other areas such as: medical clearances for firefighting personnel, provide exercise equipment for firefighters at each fire station, re-evaluate existing fitness and physical ability policies (FEMA, 2011; NIOSH, 2012), and require annual physicals be in compliant with NFPA 1582 which serves at the precursor to NFPA 1583. The following table illustrates firefighter training fatalities that have taken place since the year 2000.

Table 1

*Description of Firefighter Training Fatalities Since 2000*

Year	Gender	Training Activity	Type of PPE	Result	Investigation Recommendation	Reference
2000	Male	Structure Fire Drill	Full Structure PPE	Collapsed, pronounced dead	Phase in Mandatory fitness program	(FEMA, 2001; NIOSH, 2003)
2000	Male	Search and Rescue	Full Structure PPE	Collapsed, pronounced dead	Medical evaluations Phase in mandatory fitness program	(NIOSH, 2000; FEMA, 2001)
2000	Male	Red Card/ Wildland	Full Wildland PPE	Collapsed, pronounced dead	Stress tests Phase in mandatory fitness program	(NIOSH, 2001; FEMA, 2001)
2001	Male	Fit for Duty	Full Structure PPE	Collapsed, pronounced dead	Medical evaluations Exercise stress tests Exercise equipment	(NIOSH, 2001; FEMA, 2001)
2002	Male	Live Fire Training	Full Structure PPE	Collapsed, pronounced dead	Phase in mandatory fitness program Exercise equipment	(FEMA, 2002; NIOSH, 2003)

Table 1 (continues)

Year	Gender	Training Activity	Type of PPE	Result	Investigation Recommendation	Reference
2002	Male	Pack Test/ Wildland	Full Wildland PPE	Collapsed, pronounced dead	Check vitals before  Medical evaluations  Phase in mandatory fitness program	(FEMA, 2002; NIOSH, 2005)
2003	Male	Live Fire Training	Full Structure PPE	Collapsed, pronounced dead	Mandatory wellness program  Medical clearance  Medical evaluations	(FEMA, 2003; NIOSH, 2004)
2003	Male	Tower/ Building Climb	Full Structure PPE	Collapsed, pronounced dead	Medical clearance  Phase in mandatory fitness program	(FEMA, 2003; NIOSH, 2004)
2003	Male	Live Fire Training	Full Structure PPE	Collapsed, pronounced dead	N/A	(FEMA, 2003; NIOSH, 2006)
2005	Male	PPE clothing drill	Full Structure PPE	Collapsed, pronounced dead	Medical clearance  Medical Evaluations	(NIOSH,2007)
2007	Female	Live Fire Training	Full Structure PPE	Collapsed, pronounced dead	Screen and ensure all recruits meet requirements of NFPA 1582	(FEMA, 2007; NIOSH, 2008)

Table 1 (continues)

Year	Gender	Training Activity	Type of PPE	Result	Investigation Recommendation	Reference
2007	Male	Fire Ground Tactics	Full Structure PPE	Collapsed, pronounced dead	Medical clearance Phase in mandatory fitness program	(NIOSH, 2008)
2010	Male	Endurance Evaluation	Full Structure PPE	Collapsed, pronounced dead	Exercise stress tests Medical Clearance Phase in mandatory fitness program	(FEMA, 2010; NIOSH, 2010)
2011	Male	Entry-Level Maze Training	Full Structure PPE	Collapsed, pronounced dead	Compliance with NFPA 1582 Annual physicals Phase in mandatory fitness program	(FEMA, 2011; NIOSH, 2011)
2011	Male	Physical Ability Test	Full Structure PPE	Collapsed, pronounced dead	Strengthen annual medical assessments Fitness Policy Ability Policy	(FEMA, 2011; NIOSH, 2012)
2012	Male	Wildland Training	Full Wildland PPE	Collapsed, pronounced dead	Medical Evaluations Medical Clearance Respirator test	(FEMA, 2012; NIOSH, 2012)
2012	Male	Aerial Ladder Training	Full Structure PPE	Collapsed, pronounced dead	Phase in Mandatory fitness program	(FEMA, 2012; NIOSH, 2013)



Table 1 (continues)

Year	Gender	Training Activity	Type of PPE	Result	Investigation Recommendation	Reference
2014	Male	Air Management Training	Full Structure PPE	Collapsed, pronounced dead	Physical ability test Exercise stress tests  Phase in mandatory fitness program	(NIOSH, 2014)
2014	Male	Pack Test/ Wildland	Full Wildland PPE	Collapsed, pronounced dead	Health Screen Questionnaire  Exercise stress tests	(NIOSH, 2014)
2014	Male	Pack Test/ Wildland	Full Wildland PPE	Collapsed, pronounced dead	Health Screen Questionnaire  Phase in mandatory fitness program	(NIOSH, 2014)
2014	Male	Physical Ability Test	Full Structure PPE	Collapsed, pronounced dead	Medical Evaluations  Phase in mandatory fitness program	(NIOSH, 2015)
2015	Male	Air Management Training	Full Structure PPE	Collapsed, pronounced dead	Medical Evaluations  Phase in mandatory fitness programs	(NIOSH, 2015)
2016	Male	Search and Rescue Training	Full Structure PPE	Collapsed, pronounced dead	Exercise stress tests Physical ability tests  Phase in mandatory fitness programs.	(NIOSH, 2016)

## Summary

The literature reviewed to gather foundational information for the study included the following topics:

1. Literature Search Strategy
2. Theoretical Framework - Self-Determination theory
3. Literature Review Related Key Variables and Concepts
4. Consensus Standards
5. Development of NFPA 1583
6. Elements of NFPA 1583
7. Adherence to NFPA Standards
8. NIOSH Investigations
9. Firefighter Training Fatalities Since 2000

The concern for cardiovascular disease (CVD) which may lead to sudden cardiac arrest among firefighters was presented with supporting evidence indicating the problem and purpose for this research. The necessary items identifying the gap in knowledge and need to conduct the proposed research was also highlighted in this chapter. This research was designed and intended to help investigate an ongoing problem for individual firefighters and staff to help meet the needs of healthy and fit organization members that serve communities during times of emergency. The literature provided the information needed to construct and address the research question and provide direction for the study data-gathering instruments described in Chapter 3.

## Chapter 3: Research Method

### Introduction

The purpose of this study was to investigate individual firefighter adherence to elements of NFPA 1583 and its relationship to firefighter training fatalities. Chapter 3 presents the research components as indicated for this study. The research design, research question, population and sample along with research instruments and procedures are identified in this chapter. Additionally, quantitative data collection, literature related to data gathering methods, data analysis, informed consent sections follow highlighting the key components and steps necessary to conduct the research. The responsibilities of the researcher are described with the research procedures, data collection, and its analysis. A description of the research procedures and instruments are provided. The necessary steps for the protection of the participant rights are also indicated.

Independent and dependent variables were collected to evaluate any relationships in the research question. Covariate variables were introduced to investigate any additional individual motivators that may or may not contribute to additional relationships between the outcome and predictor variables. The collection of all data measured provided an answer to the research question. The survey consisted of four dependent continuous outcome variables and 11 independent predictor variables. Additionally, the two covariates are continuous and are divided into an intrinsic question and an extrinsic question. The independent variables are *yes/no* and *yes/no/I don't know* type questions while the dependent and covariate variables are *continuous* and *scale*. Lastly, three ordinal variables targeted demographic information to examine other relationships in the research.

### **Literature Related to Data Gathering Methods**

This study was measured quantitatively by design so that interactions among the variables were observed. As mentioned by Creswell (2009), variables need to be clearly stated and identified in an experiment so that it is evident to readers what variables are being incorporated and what outcomes are being measured. The independent variables measured adherence to NFPA 1583. These questions served as predictor variables for the study. It is understood that scientists achieve a better understanding of an identified phenomenon by studying the effect of two or more independent variables simultaneously (Frankfort-Nachmias, Nachmias & DeWaard, 2015). Complementing the study was the outcome variable known as the dependent variable. Lastly, this quantitative study incorporated a third type of variable known as a covariate which influenced some of the outcome variables. Reynolds (2007) argued that the best research design is one in which the results are so obvious that other scientists have high confidence in the results (p. 129). It was the aim of this study to produce valid and reliable conclusions that answered the research question.

### **Research Design**

The design chosen for this research was a cross-sectional study that applied quantitative approaches. Frankfort- Nachmias et al. (2015) described a cross-sectional study as one in which the researcher asks the population sample a set of questions about their backgrounds, past experiences, attitudes and so on. Frankfort-Nachnias et al. also indicated that cross-sectional studies are simply trying to describe relationships between variables. The quantitative research design was an appropriate method for this study as it measured individual firefighter adherence to health and wellness guidelines set forth by

NFPA 1583. Intrinsic and extrinsic components of motivation in self-determination theory was also examined.

The study employed a quantitative researcher-generated survey for data collection. The survey (Appendix A) asked questions that explored two components of motivation within the theoretical framework, firefighter fitness specific questions, fire department fitness program policies, individual firefighter adherence to NFPA 1583 standard questions, health wellness aspects for this research, and individual firefighter demographics.

These components of self-determination theory were critical to understanding internal and external motivators as they were used to investigate individual health and wellness (Deci & Ryan, 1985; Ryan & Deci, 2000). The survey questions and data were intended to determine individual firefighting personnel's adherence to NFPA 1583 and provide a further understanding for possible motivating factors that contributed to this adherence. The survey was completed electronically via SurveyMonkey by each participant. Individual firefighters were notified that participation was voluntary and anonymous. Frankfort-Nachmias and Nachmias (2008) identified that a cross-sectional study is cost effective and is conducted over a short period at one point in time. Further, it was mentioned that surveys are a quick and inexpensive way of collecting statistical data and information for research, prevention, and health education (Wrentz-Hudson, 2015, p. 53).

Table 2

*Description of Variables Considered in Analysis*

Question(s)	Variable name/ Category	Type of variable	How Measured	Level(s) of measurement
Q1	Exercise Periods	Dependent	Scale of 0-3 with 0 Being 0 times And 3 being 3 times	Continuous
Q2	Fitness Activities Per Shift	Dependent	Scale of 0-15min, 15-30min, 30-45min, 45-60min.	Continuous
Q3	Adherence Fitness Policy Mandatory	Independent	Yes / No	Dichotomous
Q4	NFPA 1583 Guidelines	Independent	Yes / No	Dichotomous
Q5	Exercise alone	Dependent	Scale of 0-15min, 15-30min, 30-45min, 45-60min.	Continuous
Q6	Familiar with Ch. 5 In NFPA 1583	Independent	Yes/ No/ I Don't Know	Ordinal
Q7	Fitness Coordinator	Independent	Yes/ No	Dichotomous
Q8	Fitness Trainers	Dependent	Scale of 0-5 trainers, 6-10 trainers, 11-15 trainers, 16-20 trainers.	Continuous
Q9	Exercise with other Firefighters	Covariate	Scale of 0-15min, 15-30min, 30-45min, 45-60min.	Continuous
Q10	Familiar with Ch. 6 In NFPA 1583	Independent	Yes/ No/ I Don't Know	Ordinal

Table 2 (continues)

Question(s)	Variable name/ Category	Type of variable	How Measured	Level(s) of measurement
Q11	Annual Fitness Assessment	Independent	Yes/ No	Dichotomous
Q12	Familiar with Ch. 7 In NFPA 1583	Independent	Yes/ No/ I Don't Know	Ordinal
Q13	Individualized Health/Fitness program	Independent	Yes / No	Dichotomous
Q14	Familiar with Ch. 8 In NFPA 1583	Independent	Yes/ No/	Ordinal
Q15	Required to Exercise	Covariate	Scale of 0-15 min, 15-30min, 30-45min, 45-60min.	Continuous
Q16	Adopted Elements Of NFPA 1583	Independent	Yes/ No	Dichotomous
Q17	Priority to Adhere To NFPA 1583	Independent	Yes/ No	Dichotomous
Q18	Years of Service	Independent	0-5 years, 5-10 years, 10-15 years, 15-20+years.	Ordinal
Q19	Firefighter Rank	Independent	Cadet, Firefighter, Driver, Lieutenant, Captain, Chief	Ordinal
Q20	Current Age	Independent	18-26 years, 27-35 years, 36-44 years, 45-53 years, 54+ years.	Ordinal

### **Definition of Variables**

Independent and dependent variables were collected to evaluate any relationships in the research question (Table 2). Covariate variables were introduced to investigate any additional motivators that contributed to additional relationships between the outcome and predictor variables. The collection of all data measured provided an answer to the research question. The survey consisted of four dependent continuous outcome variables and 11 independent predictor variables. Three independent ordinal variables were included in the survey. Additionally, the two covariates were continuous and divided into an intrinsic question and an extrinsic question. The independent variables were *yes/no* and *yes/no/I don't know* type questions while the dependent and covariate variables were *continuous* and *scale*. Lastly, three independent ordinal demographic variables were included to investigate all relationships between variables.

### **Independent Variables**

The independent variables addressed specific questions about NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members*. These questions included *yes/no* and *yes/no/I don't know* responses to individual firefighter adherence to NFPA 1583, fitness assessments, the presence of a fitness coordinator, familiarity with NFPA 1583, department health education programs, health and wellness lectures, and whether the individual firefighter's department maintains any existing elements of NFPA 1583. Years of service, firefighter rank, and current firefighter age are ordinal demographic variables included in the survey. The independent variables allowed for a multitude of measurement relationships for this study.



### **Dependent Variables**

The dependent variables examined individual firefighter exercise periods per shift, individual physical fitness activities per shift, firefighter fitness assessments per firefighter, and the number of firefighter fitness trainers in the organization. The dependent variables contributed to an understanding of the levels of adherence to NFPA 1583.

### **Covariate Variables**

The incorporation of two covariates in this study was essential to understand individual firefighter adherence to elements of NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members* and its relationship to training fatalities. Question 9 in the survey measured an intrinsic variable while question 15 measured an extrinsic variable. Using covariates designed for this study supported the theoretical framework by investigating intrinsic and extrinsic individual motivators of self-determination theory and contributed to outcomes. This relationship was designed to provide a further understanding of the relationships between all predictor and outcome variables.

### **Research Question**

The foundational study research question was: What factors are associated with the degree of individual firefighter adherence to elements of NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members* while controlling for motivation?

$H_0$ : After controlling for motivation, there are no differences in the degree of individual firefighter adherence to elements of NFPA 1583.

*H<sub>1</sub>*: After controlling for motivation, there are differences in the degree of individual firefighter adherence to elements of NFPA 1583.

### **Population and Sample**

The target population for this quantitative cross-sectional study included individual firefighters from paid fire departments in a rural county in a southern U.S. state. The National Fire Protection Association (2017) reported that the United States fire service is comprised of 29,727 fire departments and 345,600 paid career firefighters. This sample included 441 paid firefighters from seven paid fire departments that serve a rural county in a southern U.S. state. These firefighters meet the criteria which included: paid professional firefighter employment and serve citizens in a rural county in a southern U.S. state. I attempted to investigate this specific sample designation because 345,600 was too large for this study. Other categories of fire departments include: mostly career, mostly volunteer, and all volunteer (NFPA, 2017).

### **Recruitment of Participants**

Each department head or Fire Chief was contacted initially. The Fire Chiefs needed to grant written permission for the training officers in each of the seven fire departments to distribute the surveys electronically to all fire personnel (Appendix B). Training officers distributed an email that outlined specific details of the study that included informed consent information, voluntary participation language, specifics about the actual survey, and the link to SurveyMonkey for participation. Additionally, the email included the purpose and implications of the study as it examined firefighter fitness health and wellness. The ease of completing this short survey allowed for a quick and

efficient method of data collection for the researcher. Conclusions were drawn from the data collected.

### **Research Instruments and Procedures**

I used SurveyMonkey as the survey platform where participants answered the questions electronically. The 441 selected firefighters invited to participate in this study serve seven municipalities in a rural county in a southern U.S. state. Once the Fire Chiefs granted written permission to administer the surveys, the training officers from each fire department electronically distributed an email (Appendix D) with instructions on the research, informed consent (Appendix C), and the link to SurveyMonkey for participation. The firefighters were presented with disclosure forms and voluntary participation instructions should they choose to participate. Additionally, it was mentioned to the participant that the department head of the organization or Fire Chief has granted written permission for the training officer to administer the survey. Follow up emails to participate in the research were sent to firefighters after 1 week. This allowed the firefighters to participate at their convenience and answer the survey questions if they were unable to start the survey due to an emergency while on duty. The use of surveys to collect data continues to increase at a growth rate of 6% since 2011 (Bacon, Barlas, Dowling, & Thomas, 2017). Further, survey methods have proven to be a significant contributor for data organization and collection (p. 462).

### **Quantitative Data Collection**

Surveys provided the necessary quantitative data used for this study. Cross-sectional research is popular in the social sciences and the aim of survey questions in this type of data collection is to explore information on participants' backgrounds,

experiences, attitudes, and other related social characteristics (Frankfort-Nachmias, Nachmias, & DeWaard, 2015, p. 105). The survey data collected from individual firefighters in the seven selected fire departments that serve in a rural county in a southern U.S. state allowed myself to answer the research question and draw conclusions set forth by the design of this study and provided answers to adherence perspectives on health and wellness fitness guidelines documented in NFPA 1583. The survey was designed to measure individual firefighter responses on the degree of adherence to health and wellness elements described in NFPA 1583, their firefighter fitness experiences, and their views on providing individual fitness programming for the fire department's membership.

### **Validity and Reliability**

Validity in the research was verified by myself indicating that the survey instrument measured the variables it was designed to measure (Frankfort-Nachmias, Nachmias, & DeWaard, 2015). The fire service operates extensively by guidelines set forth by the National Fire Protection Association and in some instances, are adopted partially or entirely by the fire department. The importance of validity establishes credibility of the study. Frankfort-Nachmias et al. (2015) argued that scores in a survey helps to identify whether an instrument “might be a good one to use in survey research by establishing its validity” (p. 149).

A survey instrument's level of reliability is a compliment to the validity of the items of measurement. Frankfort-Nachmias et al., (2015) mentioned that reliability refers to the extent to which a measuring instrument contains variable errors that appear inconsistently between observations. Further, measurement in the social sciences is

primarily indirect, the number of errors that occur when variables are measured tends to be greater than when physical variables are measured (p. 135). The survey reliability was tested by a split-half method. This test estimates reliability by treating each of two or more parts of a measuring instrument separately (Frankfort-Nachmias et al., 2015). The researcher generated survey contained an even number of questions so that the survey could be equally split and tested for reliability. By using the split-half method, I increased the reliability within the same survey instrument. This supports the use of the split-half method to be used for validation of the survey instrument. The questions were divided into two groups where even numbers are one group and odd numbers are the second group. Correlation coefficients illustrated the results of both groups of questions in the survey.

### **Test Statistic**

A multiple linear regression was the statistical testing model to investigate relationships between the described variables as they were collected and transferred into SPSS statistical software to understand firefighter adherence levels to NFPA 1583. I utilized a multiple linear regression because this method assessed the relationship between two variables while controlling for the effect of others (Frankfort-Nachmias, 2015, p. 371). The electronic data collected from SurveyMonkey was in the form of an Excel spreadsheet and then imported into SPSS to run the statistical tests. Descriptive components such as percentage of firefighters who are familiar with elements of NFPA 1583, firefighters that actively participate in individual fitness assessments, and all possible relationships from the survey data were produced. All variables were used to investigate several possible relationships. Power analysis was used to determine the

sample size for this study. Software titled G\*Power (version 3.1.9.2) was the program that assisted in sample size determination. The following entries were used to establish the population sample size: Test statistic = Multiple linear regression, Alpha = 0.05, power = 0.80, effect size = 0.15, Number of predictors = 5. The calculated minimum sample size was: 92. This study aimed at reaching a minimum of 92 paid firefighters, therefore satisfying the minimum sample size as indicated by G\*Power software (version 3.1.9.2).

### **Data Analysis Plan**

The survey results were collected from SurveyMonkey and stored in the researcher's home. Data collected from the surveys are stored on the researcher's desktop and a laptop. These computers are highly secured with password protection capabilities and are in the possession of the researcher. The surveys and data will be stored for five years after the completion of the study and permanently deleted from all files and hard drives. The researcher is the only person with access to this data and requests for this information shall be in writing addressed to the researcher. The data collected was obtained from anonymous online surveys administered electronically by email to the identified individual paid firefighters. No names were associated with any participants in the study.

### **Setting**

Training officers from each of the seven indicated fire departments distributed an email to all fire personnel in their department. The ease of using this method allowed for a quick participation in the study. The email included disclaimers and permission authorization to conduct the study along with voluntary and anonymous participation

specifications. This electronic distribution provided for a quick method of providing electronic responses to the survey. The researcher included a set of instructions re-emphasizing voluntary participation and anonymous components to the study. It was mentioned that those individual firefighters that do not wish to participate in the study are not required to and no person shall know of that decision. Follow up participation email reminders sent to individual firefighters occurred after 1 week. The answers to the survey were collected electronically by SurveyMonkey and retrieved by the researcher upon completion.

### **Limitations**

The firefighters that participated in this study may have been required to respond to an emergency at any given time. This uncertainty and unpredictability of emergency response from those personnel may have hindered and produced incomplete participation to the surveys. The electronic survey presented to firefighters explained all the components of the study and indicated the significance of how important their participation was for the data collection.

### **Data Analysis**

This study followed a systematic approach for data analysis. The data gathered from the study was electronically organized and analyzed. The interpretation from the survey was used and presented in the findings section.

### **Quantitative Data Analysis**

Quantitative data was collected from a researcher-generated survey consisting of adherence questions, *yes/no* responses and *yes/no/I don't know* answers that were included in the independent variable portion of the statistical model. The dependent

variables answered continuous measurements of time, 0-15min, 15-30min, 30-45min, and 45-60min, frequency of exercise periods per shift: 0-3, and number of fitness trainers per department: 0-20. Covariate continuous variables measured increments of time, 0-15min, 15-30min, 30-45min, and 45-60min. The independent variables measured levels of individual firefighter adherence to NFPA 1583 with *yes/no* and *yes/no/I don't know* responses and an understanding of the indicated consensus standard. This section of the survey also asked whether fire departments maintain a fitness coordinator, conduct individual firefighter fitness assessments, and incorporate health and wellness educational programs for individual firefighters. The independent ordinal variable survey questions examined demographic information about each firefighter. Continuous measurements in the amount of time individual firefighters are spending on physical fitness activities were the dependent outcome variables that were analyzed for this research.

Next, physical fitness questions exploring individual firefighter assessments and the importance of fitness were included in the dependent variable portion of the statistical model. In terms of individual motivation under self-determination theory, questions were asked if fire company crews participate together in exercise for specific time periods and if individual firefighters are required to exercise for specific time periods. These covariate variables were continuous measurements based on the time allotted for physical fitness participation of each firefighter. Lastly, three demographic ordinal variables were included in the survey to help investigate possible relationships that may exist due to age, rank, and years of service. The survey results were imported in Microsoft Excel then introduced in an SPSS statistical computer program for analysis and illustration of linear relationships and distributions.



### **Informed Consent**

The informed consent portion of the study was presented in an email to each firefighter (Appendix C). This section included a description of the study, the voluntary participation clause, and information on the anonymity of the results gathered from this study. Firefighters were not required to complete the study. Individual firefighters answered survey questions on their fire department's fitness policies, individual fitness experiences, and individual firefighter adherence to NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members*. The data collected was secured and protected by the researcher and due to the anonymity of participation there was no traceable indication linking anyone who participated in this study and those who did not. The surveys were secured by SurveyMonkey and the researcher. The data collected was maintained by the researcher and secured on two computers with restricted access. The computers are password protected and the data will be destroyed after five years.

### **Summary**

This quantitative cross-sectional study was designed to examine the relationship between fire training fatalities and the degree of individual firefighter adherence to guidelines in NFPA 1583 *Standard on Health-Related Fitness Programs for Fire Department Members* while controlling for motivation. The research design, population and sample along with research instrumentation and procedures were described. Researcher roles and responsibilities in the analysis of the quantitative data collected was also outlined and explained. The survey setting and recruitment of individual participants, department head authorization information along with informed consent was

presented in this chapter. Data gathered through the presented survey methods in this chapter will be analyzed statistically and presented in Chapter 4.

## Chapter 4: Results

### Introduction

Chapter 4 begins with a review of the study purpose, foundational research question (and hypotheses), as well as data collection processes. Survey results are presented in detail and summarized at the end of the chapter.

The purpose of this quantitative study was to investigate individual firefighter adherence to elements of NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members* and its relationship to training fatalities. I reached out to 441 paid professional firefighters in a rural county in a southern U.S. state regarding their knowledge and implementation of NFPA 1583. The intent of this study was to illustrate any significant adherence by individual firefighters to fitness policies and analyze relationships between NFPA 1583 and firefighter training fatalities.

The foundational study research question was: What factors are associated with the degree of individual firefighter adherence to elements of NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members* while controlling for motivation?

$H_0$ : After controlling for motivation, there are no differences in the degree of individual firefighter adherence to elements of NFPA 1583.

$H_1$ : After controlling for motivation, there are differences in the degree of individual firefighter adherence to elements of NFPA 1583.

### Data Collection

The research required anonymous online participation through SurveyMonkey. This platform demonstrated that the surveys were distributed quickly to all professional

paid firefighters chosen for this study while maintaining privacy and anonymity. After written authorization was obtained by seven fire chiefs in person, a meeting was conducted with each of the training officers of the seven fire departments identified for participation in this study. It is through those training officers that the study was sent to all 441 professional paid firefighters. There were no issues or discrepancies with the distribution of the emails with the link to participate in the study. Once written authorization was obtained by each of the seven Fire Chiefs, the ease of information distribution was observed.

Seven fire departments selected for this study administered an electronic survey link to all fire personnel via email. On August 28, 2018, the researcher opened the link on SurveyMonkey to test the online survey. Operability of the survey was confirmed and the link was opened and maintained until data collection was complete. The first fire department (FD1) received written authorization on August 28, 2018 by the fire chief to proceed with the survey distribution process. On August 29, 2018, the same fire department (FD1) Deputy Chief of the Training Division sent out an email to the entire fire department that included the following attachments: written authorization from the Fire Chief (Appendix B), email to be sent to firefighters (Appendix D), and consent form (Appendix C).

On August 29, 2018, the following fire departments provided written authorization in person: (a) FD2, (b) FD3, (c) FD4, (d) FD5, (e) FD6, and (f) FD7. On August 31, the training officers from the following fire departments: FD2-FD7 distributed emails to all paid firefighters. The 441 professional paid firefighters were

invited to participate in this study serve in seven fire departments located in a rural county in a southern U.S. state.

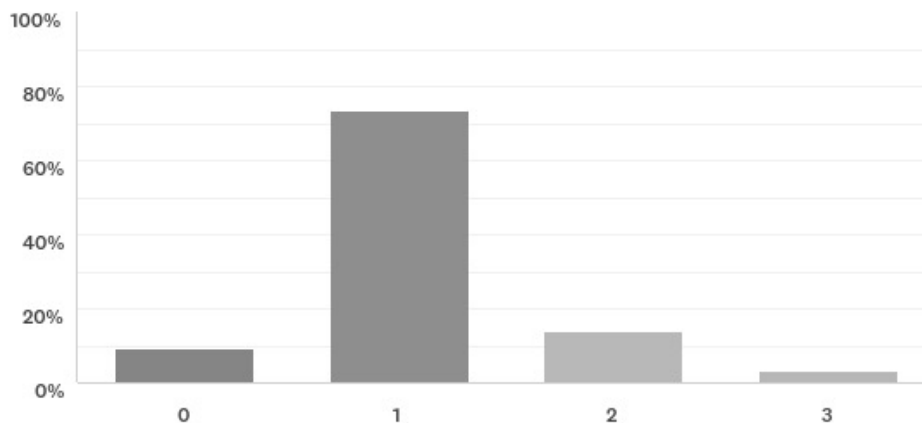
The link to SurveyMonkey was included in the information presented to all paid firefighters and the average amount of time to complete each survey was two minutes. Firefighters that had email capabilities on their smart phones could read the email and all attachments sent to them by their training officers. The link was easily accessible by any smartphone, tablet, desktop computer, and laptop that received email directions from the training officers.

Fourteen days were allowed for data collection as indicated in Chapter 3. Within the first three days, 45 responses were retrieved and collected by SurveyMonkey. After the initial email was sent to all paid professional firefighters, a follow up email was sent one week later to remind those that have not participated to do so at that time if they were unable due to emergency responses while on duty. The remaining 11 days resulted in an additional 146 survey responses for a total of 191 completed surveys. Of the 441 invitations, 191 surveys were collected resulting in a 43.3% participation rate.

## **Results**

**Survey Question 1.** On average, I exercise \_\_\_\_\_ times per shift.

All 191 participants answered this question with the following: 8.90% (17 respondents) exercise 0 times per shift, 74.87% (143) exercise 1 time per shift, 13.09% (25) exercise 2 times per shift, and 3.14% (6) exercise 3 times per shift. Figure 1 illustrates data from the 191 responses to this question.



*Figure 1. Average exercise periods per shift.*

**Survey Question 2.** I participate in physical fitness activities \_\_\_\_\_ per shift.

One hundred and ninety-one participants answered this question with the following: 7.85% (15 respondents) 0-15 minutes per shift, 13.09% (25) 15-30 minutes per shift, 26.18% (50) 30-45 minutes per shift, and 52.88% (101) 45-60 minutes per shift.

**Survey Question 3.** It is mandatory for me to adhere to a fitness policy while on duty.

Forty-three percent (83 respondents) said yes while 56.54% (108) said no to this question. All 191 answered this question.

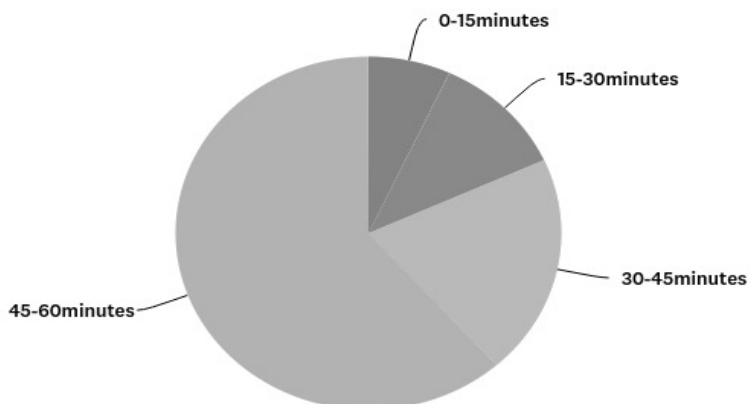
**Survey Question 4.** I am familiar with some of the guidelines outlined in NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members*.

Of the 191 respondents, 58.64% (112 respondents) said yes, 41.36% (79) said no.

**Survey Question 5.** I enjoy exercising by myself in the gym for:

Seven percent (14 respondents) exercise 0-15 minutes, 10.47% (20) 15-30 minutes, 20.94% (40) 30-45 minutes, and 61.26% (117) 45-60 minutes (see Figure 2).

All 191 respondents answered this question.



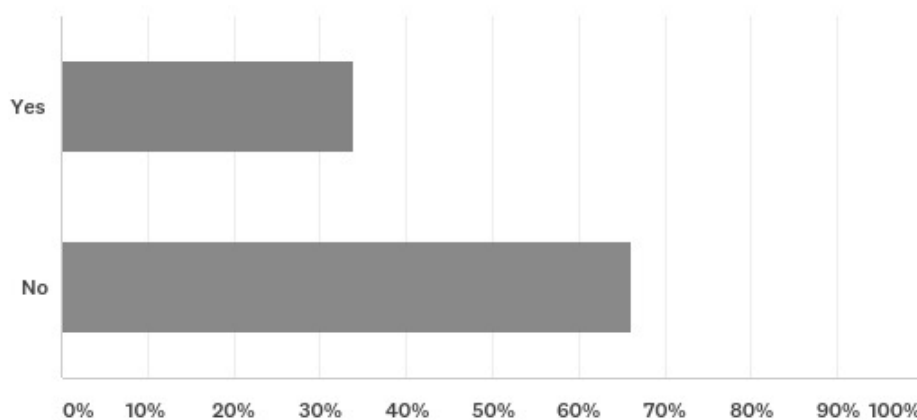
*Figure 2.* Time spent exercising alone.

**Survey Question 6.** I am familiar that in NFPA 1583 the Fire Chief shall appoint a health and fitness coordinator and peer fitness trainers.

Thirty-five percent (67 respondents) said yes and 24.61% (47) said no. 40.31% (77) responded with I don't know. All 191 participants answered this question.

**Survey Question 7.** My department has a fitness coordinator to help my fitness needs and requirements.

All 191 respondents answered this question. 33.51% (64 respondents) answered yes. 66.49% (127) answered no. Figure 3 illustrates these answers.



*Figure 3.* Presence of a fitness coordinator.

**Survey Question 8.** My department has \_\_\_\_\_ fitness trainers as identified in NFPA 1583.

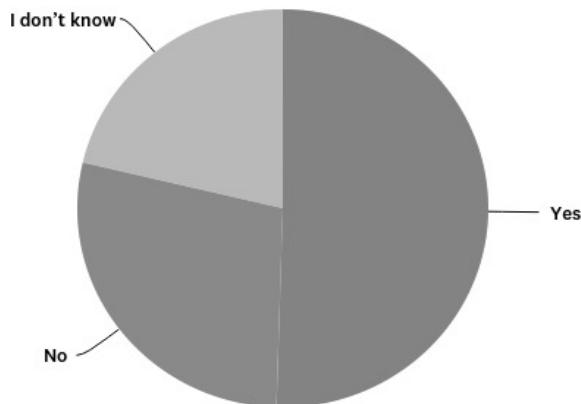
Eighty-one percent (155 respondents) have 0-5 trainers, 12.57% (24) answered 6-10 trainers, 3.14% (6) answered 11-15 trainers, and 3.14% (6) answered 16-20 trainers. All 191 respondents answered this question.

**Survey Question 9.** I choose to exercise with other firefighters:

Nineteen percent (36 respondents) exercise 0-15 minutes, 15.18% (29) exercise 15-30 minutes, 23.56% (45) exercise 30-45 minutes, and 42.41% (81) exercise 45-60 minutes. All 191 answered this question.

**Survey Question 10.** I am familiar that in NFPA 1583 my fire department shall conduct fitness assessments for each firefighter.

Fifty-one percent (96 respondents) said yes and 28.95% (55) said no. 20.53% (39) responded with I don't know (see Figure 4). One hundred and ninety respondents answered this question. One respondent did not.



*Figure 4.* Knowledge of fitness assessments identified in NFPA 1583.



**Survey Question 11.** I am required to complete an annual fitness assessment for my job while on duty.

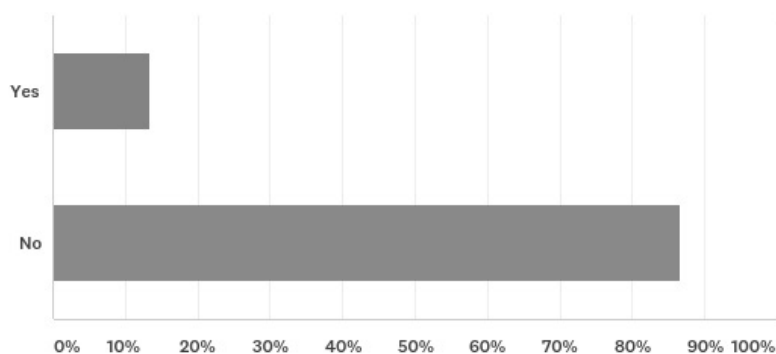
One hundred and ninety responded to this question. One responded did not. 53.68% (102 respondents) answered yes and 46.32% (88) answered no.

**Survey Question 12.** I am familiar that in NFPA 1583 my department will implement an exercise and fitness training program.

One hundred and ninety-one respondents answered this question. 41.36% (79 respondents) answered yes, 32.98% (63) answered no, and 25.65% (49) answered I don't know.

**Survey Question 13.** I have an individualized fitness program provided to me by my department's health and fitness coordinator and trainers.

Fourteen percent (26 respondents) answered yes and 86.39% (165) answered no. One-hundred ninety-one answered this question. Figure 5 illustrates these indicated results.



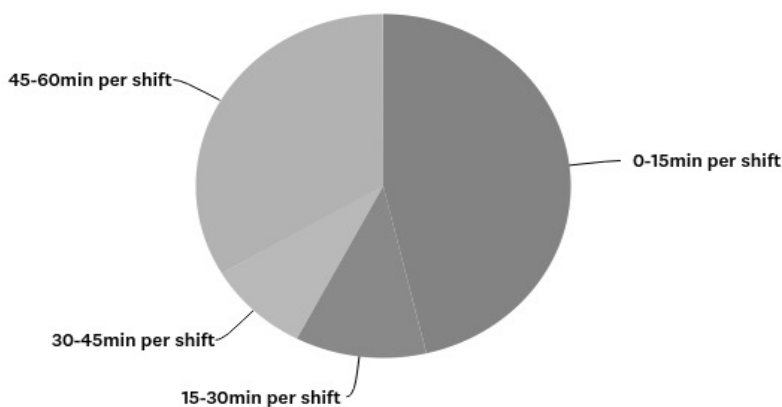
*Figure 5.* Individualized fitness program provided to individual firefighters.

**Survey Question 14.** My department promotes individualized health education as mentioned in NFPA 1583 for health and fitness.

All 191 respondents answered this question. 34.03% (65 respondents) said yes and 65.97% (126) said no.

**Survey Question 15.** Individual firefighters are required to exercise:

One hundred and ninety-one answered this question. 48.17% (92 respondents) exercise 0-15 minutes per shift, 11.52% (22) exercise 15-30 minutes per shift, 8.38% (16) exercise 30-45 minutes per shift, and 31.94% (61) exercise 45-60 minutes per shift (see Figure 6).



*Figure 6.* Time spent exercising as per department policy.

**Survey Question 16.** My department has adopted some of the described elements of NFPA 1583 in its health and fitness program.

All 191 respondents answered this question. 50.79% (97 respondents) answered yes and 49.21% (94) answered no.

**Survey Question 17.** It is a priority for me to adhere to NFPA 1583 when participating in a fitness program.

Forty-four percent (84 respondents) answered yes and 56.02% (107) answered no (see Figure 7). All 191 respondents answered this question.

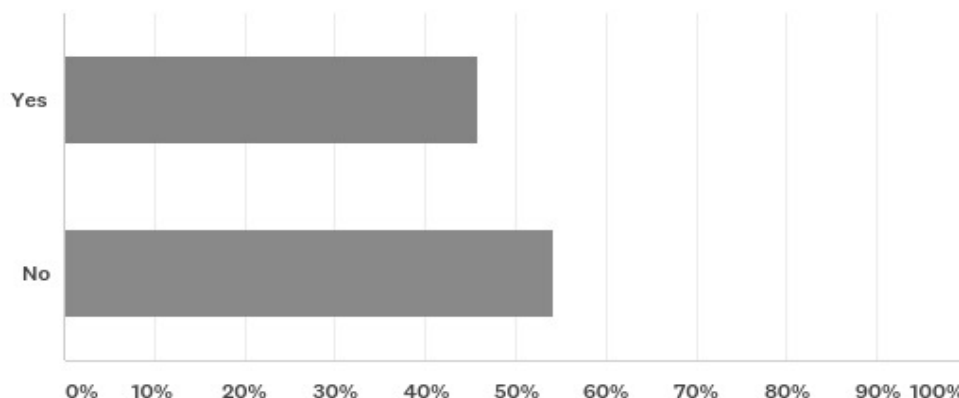


Figure 7. Priority to adhere to NFPA 1583.

**Survey Question 18.** How many years have you been a professional firefighter?

All 191 respondents answered this question. 41.36% (79 respondents) answered 0-5 years, 26.18% (50) answered 5-10 years, 15.71% (30) answered 10-15 years, and 16.75% (32) answered 15-20+ years.

**Survey Question 19.** What rank do you currently hold in your fire department?

Two percent (4 respondents) answered cadet, 62.11% (118) answered firefighter, 13.68% (26) answered driver, 10.53% (20) answered lieutenant, 6.32% (12) answered captain, and 5.26% (10) answered chief (see Figure 8). One hundred ninety respondents answered this question. One respondent did not.

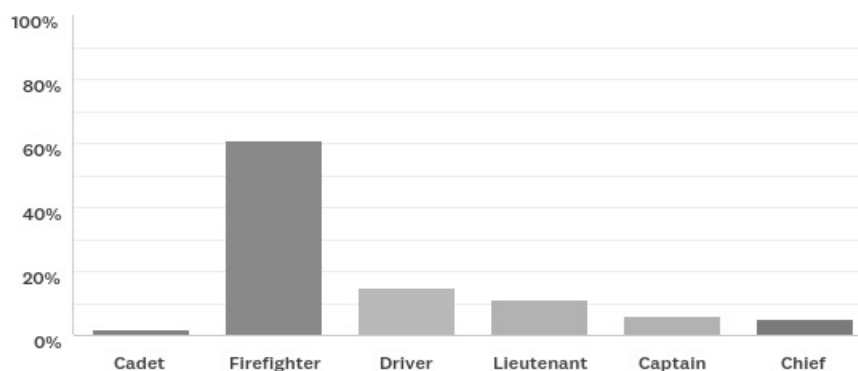


Figure 8. Current rank of respondents.

**Survey Question 20.** What is your current age?

All 191 respondents answered this question. 26.70% (51 respondents) are 18-26 years of age, 37.70% (72) are 27-35 years of age, 23.56% (45) are 36-44 years of age, 10.99% (21) are 45-53 years of age, and 1.05% (2) are 54-62 years of age.

**Linear Regression Analysis**

To effectively interpret the data results and produce viable statistical analyses, I conducted four separate linear regression procedures that collectively contributed to a multiple linear regression method. The study consisted of four independent variables that measured specific elements to NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members*. The described independent variables were: In NFPA 1583, the Fire Chief shall appoint a health and fitness coordinator and peer fitness trainers, the fire department shall conduct fitness assessments for each firefighter, implementation of an exercise and fitness training program, and individualized health education promotion as mentioned in NFPA 1583. These independent variables were designed to gather responses to help contribute to an understanding of the levels of adherence to this NFPA 1583 standard. In addition, the research included four dependent variables that measured specific elements to NFPA 1583. The dependent variables were: number of exercise periods per shift, participation in physical activities per shift (measured in minutes), exercise alone (measured in minutes), and the number of fitness trainers present in the fire departments. In each separate linear regression analysis, one dependent variable was measured against the four independent variable elements of the NFPA 1583 standard.

The first dependent variable that was used in the first linear regression analysis was the number of workouts per shift. A Pearson correlation coefficient ( $R$ ) indicated the multiple correlation relationship as follows:  $R = 0.270^a$ . This value is a weak linear association between the dependent and independent variables. The proportion of variance, or  $R^2$  illustrated any variance between the number of workouts per shift explained by the independent variables: chief appoints a fitness coordinator, fire department conducts assessments as indicated by NFPA 1583, implement an exercise fitness training program, and the fire department provides individualized health education. The  $R^2 = 0.073$  indicated the independent variables explained 7.3% of the variability of the number of workouts per shift. The covariate variables: I choose to exercise with other firefighters and individual firefighters are required to exercise produced  $R = 0.456^b$ . This value is a moderate linear association between the dependent variable, independent variables, and covariate variables in model 2. The R square value in model 2 presented a result of  $R^2 = 0.208$  illustrating the covariates maintain a 20.8% influence on the outcome variables (see Table 3). A Durbin-Watson value of 1.652 falls within normal range to indicate a positive autocorrelation (Field, 2009).

Table 3

*Workout Periods Model Summary*

Model	R	R Square	Adjusted R Square	St. Error of the Estimate	Durbin-Watson
1	.270 <sup>a</sup>	.073	.034	.632	1.652
2	.456 <sup>b</sup>	.208	.157	.590	

Note. a.Predictors: (Constant), IndHealthPromo, ExFitProgram, ChAppointsFC, AssbyNFPA1583

b.Predictors: (Constant), IndHealthPromo, ExFitProgram, ChAppointsFC, AssbyNFPA1583, IChToEx, ReqToEx

c.Dependent variable: WOPerShift

The statistical significance from the first linear regression was next observed. The following describes the variables that were used in the analysis. The number of workouts per shift dependent variable (DV) measured against the four identified independent variables (IV) produced a  $p$ -value of .118<sup>b</sup> in model 1. The Covariate variables: I choose to exercise with other firefighters and individual firefighters are required to exercise produced a  $p$ -value of .001<sup>c</sup> in model 2. The results from the first model did not indicate statistical significance. Model 2 values indicated statistically significant results. Further, the complete hierarchical linear regression results from the first analysis between DV, IVs, and covariates are as follows:  $F(4, 96) = 1.892, p > .05$  and  $F(6, 94) = 4.114, p < .05$  (see Table 4).

Table 4

*Workout Periods ANOVA<sup>a</sup>*

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.019	4	.755	1.892	.118 <sup>b</sup>
	Residual	38.308	96	.399		
	Total	41.327	100			
2	Regression	8.596	6	1.433	4.114	.001 <sup>c</sup>
	Residual	32.731	94	.348		
	Total	41.327	100			

Note. a. Dependent Variable: WOPerShift

b. Predictors: (Constant), IndHealthPromo, ExFitProgram, ChAppointsFC, AssbyNFPA1583

c. Predictors: (Constant), IndHealthPromo, ExFitProgram, ChAppointsFC, AssbyNFPA1583, IChToEx, ReqToEx

The next variable used was fitness activity minutes per shift. A Pearson correlation coefficient ( $R$ ) indicated the multiple correlation relationship as follows:  $R = 0.442^a$ . This presented a moderate linear association. The proportion of variance, or  $R^2$  illustrated any variance between fitness activity minutes per shift explained by the following independent variables: chief appoints a fitness coordinator, fire department

conducts assessments as indicated by NFPA 1583, implement an exercise fitness training program, and the fire department provides individualized health education. The  $R^2 = 0.195$  indicated that the independent variables explained 19.5% of the variability of the fitness activity minutes per shift. The covariate variables: I choose to exercise with other firefighters and individual firefighters are required to exercise produced  $R = 0.692^b$ . This value presented a strong linear association between the dependent variable, independent variables, and covariate variables in model 2. The R square value in model 2 presented a result of  $R^2 = 0.479$  illustrating the covariates maintain a 47.9% influence on the outcome variables (see Table 5). A Durbin-Watson value of 1.673 falls within normal range to indicate a positive autocorrelation (Field, 2009).

Table 5

*Physical Fitness Activity Model Summary*

Model	R	R Square	Adjusted R Square	St. Error of the Estimate	Durbin-Watson
1	.442 <sup>a</sup>	.195	.161	.922	1.673
2	.692 <sup>b</sup>	.479	.446	.750	

*Note.* a. Predictors: (Constant), IndHealthPromo, ExFitProgram, ChAppointsFC, AssbyNFPA1583

b. Predictors: (Constant), IndHealthPromo, ExFitProgram, ChAppointsFC, AssbyNFPA1583, IChToEx, ReqToEx

c. Dependent variable: PTminPerShift

The statistical significance from the second linear regression was next observed. The fitness activity minutes per shift (DV) measured against the four identified independent variables (IV) produced a  $p$ -value of .000<sup>b</sup> in model 1. The Covariate variables: I choose to exercise with other firefighters and individual firefighters are required to exercise produced a  $p$ -value of .000<sup>c</sup> in model 2. The results from model 1 and model 2 were statistically significant. The complete hierarchical linear regression

results from the second analysis between DV, IVs, and covariates are as follows:  $F(4, 96) = 5.811, p < .0005$  and  $F(6, 94) = 14.396, p < .0005$  (see Table 6).

Table 6

*Physical Fitness Activity ANOVA<sup>a</sup>*

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	19.779	4	4.945	5.811	.000 <sup>b</sup>
	Residual	81.686	96	.851		
	Total	101.465	100			
2	Regression	48.588	6	8.098	14.396	.000 <sup>c</sup>
	Residual	52.877	94	.563		
	Total	101.465	100			

Note. a. Dependent Variable: PTminPerShift

b. Predictors: (Constant), IndHealthPromo, ExFitProgram, ChAppointsFC, AssbyNFPA1583

c. Predictors: (Constant), IndHealthPromo, ExFitProgram, ChAppointsFC, AssbyNFPA1583, IChToEx, ReqToEx

The third dependent variable that was used in another linear regression analysis was exercising alone in the gym. A Pearson correlation coefficient ( $R$ ) indicated the multiple correlation relationship as follows:  $R = 0.166^a$ . This value presented a weak linear association between the dependent variable and independent variables. The proportion of variance, or  $R^2$  illustrated any variance between exercising alone in the gym explained by the following independent variables: chief appoints a fitness coordinator, fire department conducts assessments as indicated by NFPA 1583, implement an exercise fitness training program, and the fire department provides individualized health education. The  $R^2 = 0.027$  indicated that the independent variables explained 2.7% of the variability in the exercising alone variable. The covariate variables: I choose to exercise with other firefighters and individual firefighters are required to exercise produced  $R = .208^b$ . This value presented a weak linear association between the dependent variable,



independent variables, and covariate variables in model 2. The R square value in model 2 presented a result of  $R^2 = 0.043$  illustrating the covariates maintain a 4.3% influence on the outcome variables (see Table 7). A Durbin-Watson value of 1.908 falls within normal range to indicate a positive autocorrelation (Field, 2009).

Table 7

*Exercise Alone Model Summary*

Model	R	R Square	Adjusted R Square	St. Error of the Estimate	Durbin-Watson
1	.166 <sup>a</sup>	.027	-.013	.922	1.908
2	.208 <sup>b</sup>	.043	-.018	.924	

Note. a. Predictors: (Constant), IndHealthPromo, ExFitProgram, ChAppointsFC, AssbyNFPA1583

b. Predictors: (Constant), IndHealthPromo, ExFitProgram, ChAppointsFC, AssbyNFPA1583, IChToEx, ReqToEx

c. Dependent variable: ExerciseAlone

The statistical significance from the third linear regression was next observed. The exercising alone in the gym (DV) measured against the four identified independent variables (IV) produced a  $p$ -value of .609<sup>b</sup> in model 1. The Covariate variables: I choose to exercise with other firefighters and individual firefighters are required to exercise produced a  $p$ -value of .641<sup>c</sup> in model 2. The results from both models did not indicate statistical significance. Further, the complete hierarchical linear regression results from the third analysis between DV, IVs, and covariates are as follows:  $F(4, 96) = 0.678, p > .05$  and  $F(6, 94) = 0.711, p > .05$  (see Table 8).

Table 8

*Exercise Alone ANOVA<sup>a</sup>*

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.308	4	.577	.678	.609 <sup>b</sup>
	Residual	81.633	96	.850		
	Total	83.941	100			
2	Regression	3.646	6	.608	.711	.641 <sup>c</sup>
	Residual	80.295	94	.854		
	Total	83.941	100			

Note. a. Dependent Variable: ExerciseAlone

b. Predictors: (Constant), IndHealthPromo, ExFitProgram, ChAppointsFC, AssbyNFPA1583

c. Predictors: (Constant), IndHealthPromo, ExFitProgram, ChAppointsFC, AssbyNFPA1583, IChToEx, ReqToEx

The fourth dependent variable that was used in the final linear regression analysis was the presence of fitness trainers. A Pearson correlation coefficient ( $R$ ) indicated the multiple correlation relationship as follows:  $R = 0.395^a$ . This value presented a moderate linear association between the dependent variable and independent variables. The proportion of variance, or  $R^2$  illustrated any variance between the presence of fitness trainers explained by the following independent variables: chief appoints a fitness coordinator, fire department conducts assessments as indicated by NFPA 1583, implement an exercise fitness training program, and the fire department provides individualized health education. The  $R^2 = 0.156$  indicated that the independent variables explained 15.6% of the variability in the presence of fitness trainers. The covariate variables: I choose to exercise with other firefighters and individual firefighters are required to exercise produced  $R = 0.396^b$ . This value presented a moderate linear association between the dependent variable, independent variables, and covariate variables in model 2. The R square value in model 2 presented a value of  $R^2 = 0.157$

illustrating the covariates maintain a 15.7% influence on the outcome variables (see Table 9). A Durbin-Watson value of 2.089 falls within normal range to indicate a positive autocorrelation (Field, 2009).

Table 9

*Fitness Trainers Model Summary*

Model	R	R Square	Adjusted R Square	St. Error of the Estimate	Durbin-Watson
1	.395 <sup>a</sup>	.156	.120	.760	2.089
1	.396 <sup>b</sup>	.157	.103	.768	

Note. a. Predictors: (Constant), IndHealthPromo, ExFitProgram, ChAppointsFC, AssbyNFPA1583

b. Predictors: (Constant), IndHealthPromo, ExFitProgram, ChAppointsFC, AssbyNFPA1583, IChToEx, ReqToEx

c. Dependent Variable: FitTrainers

The statistical significance from the final linear regression was next observed. The presence of fitness trainers (DV) measured against the four identified independent variables (IV) produced a  $p$ -value of .003<sup>b</sup> in model 1. The Covariate variables: I choose to exercise with other firefighters and individual firefighters are required to exercise produced a  $p$ -value of .012<sup>c</sup> in model 2. The results from the first and second models indicated statistical significance. Further, the complete hierarchical linear regression results from the final analysis between DV, IVs, and covariates are as follows:  $F(4, 96) = 4.424, p < .05$  and  $F(6, 94) = 2.907, p < .05$  (see Table 10).

Table 10

*Fitness Trainers ANOVA<sup>a</sup>*

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10.226	4	2.556	4.424	.003 <sup>b</sup>
	Residual	55.477	96	.578		
	Total	65.703	100			
2	Regression	10.283	6	1.714	2.907	.012 <sup>c</sup>
	Residual	55.420	94	.590		
	Total	65.703	100			

Note. a. Dependent Variable: FitTrainers

b. Predictors: (Constant), IndHealthPromo, ExFitProgram, ChAppointsFC, AssbyNFPA1583

c. Predictors: (Constant), IndHealthPromo, ExFitProgram, ChAppointsFC, AssbyNFPA1583, IChToEx, ReqToEx

**Split-Half Reliability**

This study utilized a researcher generated survey instrument to collect responses from 441 professional firefighters. One hundred and ninety-one total responses were collected by professional firefighters in a rural county in a southern U.S. state. To test the reliability of this research instrument, a split-half reliability procedure was conducted to illustrate internal reliability results. Reliability is estimated by treating each of two or more parts of a measuring instrument separately (Frankfort-Nachmias et al., 2015). The results from the reliability procedure indicated a Cronbach's Alpha of  $\alpha = 0.791$  or  $\alpha = 0.8$  (see Table 11). The following are Cronbach's Alpha internal reliability scores:  $0.8 > \alpha \geq 0.7$  acceptable,  $0.9 > \alpha \geq 0.8$  good, and  $\alpha \geq 0.9$  excellent. An alpha of .65-.80 is often considered adequate for a scale used in human dimension research (Vaske, Beaman, & Sponarski, 2017).

Table 11

*Split-Half Reliability Statistics*

Cronbach's Alpha	N of Items
.791	20

**Summary**

This chapter included a detailed description of the study data. Multiple linear regression methods and survey reliability results were presented and tables were included for this cross-sectional quantitative study. The intent of this research was to examine what factors are associated with the degree of individual firefighter adherence to elements of NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members*, while controlling for motivation. My inferential analysis revealed that some of the elements maintained a significant role in predicting some of the outcomes while motivation produced further significant results. This allowed the researcher to reject the null hypothesis:  $H_0$ : After controlling for motivation, there are no differences in the degree of individual firefighter adherence to elements of NFPA 1583. Chapter 5 includes the integration, synthesis and interpretation of the survey findings and the literature review as it relates to the Research Question. The chapter concludes with a presentation of study social change implications.

## Chapter 5: Discussion

### Introduction

The purpose of this cross-sectional quantitative research was to examine individual firefighter adherence to fitness policies as indicated in National Fire Protection Association Standard 1583, *Standard on Health-Related Fitness Programs for Fire Department Members*. By investigating this phenomenon, I provided an understanding of factors associated with adherence to this policy, motivation components of individual firefighters to fitness programs, and its relationship to firefighter training fatalities. The data was analyzed using descriptive analysis and multiple linear regression techniques. The results indicated that after controlling for motivation, there were differences in the degree of individual firefighter adherence to elements of NFPA 1583 therefore, the null hypothesis was rejected. This chapter includes my inferential interpretations of the research findings, limitations of this study, recommendations for further research, and a discussion about the social change implications from my findings.

Based on the results of the study, this chapter presents conclusions related to the research question: What factors are associated with the degree of individual firefighter adherence to elements of NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members* while controlling for motivation?

Firefighter adherence to NFPA 1583 was examined by investigating four identified elements contained within the standard while also measuring two types of motivation to observe additional relationships. Three out of the four elements displayed significant results and motivation was shown to be significant in three relationship outcomes.

### **Interpretation of the Findings**

The aim of this study was to investigate individual firefighter adherence to specific elements of NFPA 1583. The NFPA 1583 Standard contains five elements that can be used by fire departments as a guide for promoting positive health and wellness of firefighters. As mentioned by Marsh et al., (2018), The NFPA 1583 Standard on Health-Related Fitness Programs is a positive, non-punitive tool that outlines five components that fire departments can implement to improve members' health and fitness. My study examined two types of individual firefighter motivation and four specific elements of the NFPA 1583 standard. Three out of the four analyses of these elements produced statistically significant results. The four elements are described as: (a) The fire chief appoints a fitness coordinator for the fire department to oversee a health and fitness program, (b) have paid professional firefighters participate in annual fitness assessments as indicated in NFPA 1583, (c) implement an exercise and fitness training program, and (d) promote individualized health education as outlined in NFPA 1583.

The four identified factors were presented, measured, and analyzed to effectively provide an understanding of individual firefighter adherence to NFPA 1583. These independent variables were collectively measured against four specific separate dependent variables and produced varying results from the statistically analyzed relationships. Each of the analyses offered varying degrees of relationship coefficients and analysis. Collectively, the observation of all the analyses assisted in answering the research question. It was my interpretation from the results to reject the null based on the collected and observed differences in the degree of individual firefighter adherence to the identified elements of NFPA 1583.

### **Self-Determination Theory**

Individual motivation was measured by asking specific questions about fitness participation. These motivating factors, rooted in self-determination theory were essential to understanding levels of adherence to fitness policies by exploring relationships between the dependent and independent variables and any influences they had on the observed outcomes. These components of self-determination theory are critical to understanding internal and external individual motivators as they are used to investigate health and wellness (Deci & Ryan, 1985; Ryan & Deci, 2000).

My findings indicate that 42% of firefighters choose to exercise for 45min-60min on their own compared to 32% of those that are told to exercise by rules from standard operating procedures. Additionally, 19% of firefighters choose to exercise 0min-15min on their own compared to 48% of firefighters that exercise for the same duration when advised to exercise by rules and existing standard operating procedures (SOPs). This finding is in support of Deci & Ryan (2000) as they mentioned that self-determination theory examines both intrinsic motivation, displaying a natural and essential level of self-enjoyment and extrinsic motivation prompted by outcomes outside of self.

Current research by Poplin et al. (2018) postulate that despite the existence of a standard operating procedure describing the requirements for physical fitness, the level of awareness, enforcement and adherence to the SOPs had previously been inconsistent throughout.

When comparing this study's results with self-determination theory, similarities and differences exist. My findings indicate inconsistencies between the amount of time that paid firefighters participate in physical fitness activities along with the type of



motivation that was used to engage in exercise, i.e. intrinsic motivation vs. extrinsic motivation. However, it was indicated in three out of the four linear regression models that the covariate variables for motivation illustrated statistically significant influences on the outcome variables.

### **Number of Workouts Per Shift Against Elements of NFPA 1583**

The first analysis was conducted by measuring the four elements of the NFPA 1583 standard against the number of workouts per shift by individual firefighters. My findings indicated that initially there was no significance until the covariates were introduced in the data analysis. Individual motivation influence on the outcome produced statistically significant results. I found that by having both motivating factors in the analysis together assisted in producing significance throughout the data collection portion of the study. It is understood that scientists achieve a better understanding of an identified phenomenon by studying the effect of two or more variables simultaneously (Frankfort-Nachmias et al., 2015).

I have concluded that the number of workouts per shift measured against the four elements of NFPA 1583, while controlling for motivation produced a significant finding from the influence of intrinsic and extrinsic motivators as identified in self-determination theory. This presented the first evidence of covariate influence on the outcomes. However, in the absence of motivation, the analysis revealed no significance. My findings from a covariate influence on the predictor variables are consistent with the literature provided by Boyd (2016), as it was mentioned that these components help further understand and investigate health-related behaviors. The results from this first analysis presented a difference as indicated by the alternative hypothesis.

### **Fitness Activity Against Elements of NFPA 1583**

My findings from the second linear regression analysis produced different results from the first regression. Fitness activity, measured in minutes per shift was observed against the four elements described in NFPA 1583. Statistically significant results were the strongest in this analysis— $p = 0.000$  model 1 and  $p = 0.000$  model 2. My interpretation from this analysis strongly support the theory that by having the described elements of NFPA 1583 in fire departments, physical fitness activity significantly increased despite the influence of any covariate variables. The overall wellness of the professional firefighter is influenced by incorporating elements of NFPA 1583, specifically the element of health education as a guide for fitness activity. The results of this study would agree with the literature regarding the importance of fitness activity per shift. This can be encouraged by departments through worksite health promotion (Marsh et al., 2018). This study adds to the literature in that there is significance for professional firefighters' participation in fitness activities while contributing to the overall health of the firefighter.

My interpretation from the results of this study, as it pertains to the safety and wellness of the professional firefighter during training, is that all fitness activity will aid in fire ground emergencies as well as in controlled training environments. This activity can be on the fire ground or in a fitness designated area that could be used by firefighters. The results from this study are consisted with research by Ensari et al., (2017) indicating that physiological responses measured from firefighters working in a controlled environmental chamber were similar to those reported from typical live fire training activities and response scenarios (p. 663).

### **Exercising Alone Against Elements of NFPA 1583**

In a third linear regression that measured exercising alone in the gym against the four indicated elements to NFPA 1583, my findings indicated that there were no significant findings throughout that analysis. Individual motivation was also incorporated into the analysis and equally produced no significant results in the regression model. My interpretation from these results indicate that despite any elements from NFPA 1583 and implementation of the standard into the department's standard operating procedures, firefighters will continue to enjoy participating in exercise alone in the gym for reasons unknown to this study. These findings contribute to further differences in the degree of individual firefighter adherence to elements of NFPA 1583 as mentioned in the alternative hypothesis to this research.

### **Fitness Trainers Against Elements of NFPA 1583**

The last linear regression measured the presence of fitness trainers against the four indicated elements to NFPA 1583. The literature presented that the fire chief is to determine a health and fitness coordinator who works with peer fitness trainers while they "coordinate and oversee safe participation in health-related programs" (NFPA, 2014, p. 7). This analysis produced significant results both with the dependent variable alone and with the influence of the covariate variables.

My findings indicate that having a fitness trainer of any kind help promote and educate professional firefighters on the proper techniques of exercise, health and wellness lifestyle habits, nutrition, along with other services that fitness trainers provide. Ensuring that staff are trained on safe lifting techniques, the use of ergonomically appropriate equipment, and the importance of proper physical fitness can potentially lead to improved

firefighter safety and health (Marsh, et al., 2018). My interpretation from this is that a fitness trainer can significantly improve overall wellness to paid professional firefighters in the fire department. The results of this study would agree with the work by Nazari et al., (2018) indicating how studies have demonstrated a direct association between better firefighting job performance with higher levels of fitness.

Additionally, my interpretations from this last linear regression allow me to conclude that the presence of a health and fitness coordinator contributed to the strongest significance in the study. Motivation components equally produced statistically significant results, and by these findings, I observed further differences in the level of adherences by individual firefighters as indicated by the alternative hypothesis ( $H_1$ ).

### **Firefighter Fitness Survey**

The researcher generated survey measured other components to fitness adherence outside the intrinsic and extrinsic parameters. Seventy-four percent of paid professional firefighters workout once per shift with 52% of the respondents participating in 45-60 minutes per shift. One hundred and seventeen respondents also indicated that they exercised alone for durations of up to 60 minutes (61.26%). The results from this study support current literature that indicates to execute physically demanding jobs properly and safely, firefighters should achieve and maintain some degree of physical fitness (Marsh, Gwilliam, Konda, Tiesman, & Fahy, 2018, p. 357). The survey results on mandatory adherence to fitness policies was almost equally divided—43% of the respondents said yes while 56.54% responded with no. My interpretation from the survey results are consistent with firefighters understanding the importance of the

physical fitness requirements of the job despite a written policy that may indicate those expectations.

This study measured specific elements to the NFPA 1583 standard and individual perceptions, experiences, and views on adherence to this standard were also observed. To produce results and interpret relationships, I generated a survey that would measure very specific elements to the NFPA 1583 standard, along with what influences individual firefighter motivation may have on the predicted outcomes. This was the first time a survey instrument of this kind was utilized in a quantitative study measuring fitness policy adherence, therefore, it was subject to reliability evaluation. As indicated in Chapter 3, a split-half reliability was necessary to illustrate the survey instrument's reliability in its variable measurement responsibility. A Cronbach's Alpha  $\alpha = .8$  indicated a good scoring. My interpretation to this finding allowed me to validate all the variables collected, measured, and analyzed in all the necessary statistics used for this study.

### **Limitations of the Study**

The first limitation as indicated in Chapter 1, mentioned that this research targeted one county in a southern U.S. state. There are many counties within that U.S. state and this research did not target the remaining counties. Additionally, the remaining 49 states in the United States were excluded from any participation in this study. Implications may not be generalizable due to these limitations.

I mentioned in Chapter 3 that firefighters may be required to respond to an emergency at any given time while on duty. This limitation may have reduced the number of survey participation.

As the research was preparing for data collection, there were required steps necessary to be completed before any information could be obtained by the identified participants. Written authorization from each of the seven fire chiefs would need to be provided before the sequential procedures could begin. The fire chief for the first fire department under study provided a signature immediately on August 28, 2018. This allowed me to meet with the deputy chief of training to begin the information circulation to all paid professional firefighters in FD1.

A limitation for email distribution was addressed during the meeting because a mass email distribution would not have met the criteria that was indicated for this study. The email procedure by the deputy chief required him to eliminate any staff that were not paid professional firefighters. The administrative clerical staff and noncivil service employees were excluded from email distribution. This allowed for a more accurate email circulation with information instructions to the survey.

Another limitation was trying to coordinate and obtain the remaining six signatures from the other fire chiefs invited to participate in this study. On August 29, 2018, the local County Fire Chiefs had their monthly meeting and I was invited to attend. During this meeting, all remaining six required signatures were obtained in person.

A final possible limitation to the study was the time of the year that the survey was administered. After all signatures were obtained from the fire chiefs on August 29, 2018, the next two days were dedicated to meeting with all fire training officers. This critical step was necessary for survey distribution to all paid firefighting personnel. After several phone calls, it was indicated that it was Labor Day weekend and that some of the officers were out of town and there may be a delay in survey distribution. Most training

officers disseminated emails and survey instructions immediately. As the principal investigator to this research, I was unable to see which emails were distributed to firefighters and was not provided with a time and day of the email circulations. A second email to firefighting personnel, as indicated in the methodology, assisted in survey responses collected for this research.

### **Recommendations**

My research examined how southern U.S. professional firefighters adhere to a health and wellness policy identified by the National Fire Protection Association. In a quest to identify relationships between adherence to NFPA 1583 and firefighter training fatalities, analyses were conducted and interpretations were presented. The first initial recommendation is to have more municipalities that contain a larger number of firefighting personnel included in further studies. This will allow the researcher to examine larger departments that may have more resources and examine adherence to NFPA 1583 more closely. I recommend that paid professional firefighters from larger departments participate because some of the work volume and services required from a bigger department are amplified and may require more firefighting personnel to maintain higher levels of fitness. Large fire departments also contain divisions, such as the training division that is solely in charge of conducting trainings for all firefighting personnel. To provide safer services to firefighting personnel, larger departments may be able to fully capitalize on the results from this study in their training objectives, especially the safety component to their membership.

I recommend that all elements to NFPA 1583 be examined in further studies, not limited to the four elements used in this research. By looking at the standard in its

entirety, more relationships could be observed and more analyses could be conducted as it explores adherence levels by individual firefighters. In turn, the survey instrument used in this research can be expanded to measure the additional element to NFPA 1583 not incorporated in the present research and provide a further understanding to adherence to the given standard and its relationship to firefighter training fatalities.

More credibility could be given to this study if coupled with qualitative research. For example, while collecting data through surveys provided enough information for statistical significance in some elements, I recommend future studies incorporate interviews with training officers to examine some of the standard operating procedures utilized in large departments. Lastly, I recommend examining different ranks such as cadet, firefighter, driver, captain, etc. individually to produce other outcomes on future studies. These observations paired with survey collection methods could provide a further understanding and closer look at health and wellness protocols that are in place for the professional firefighter.

Although data collection for the current study yielded sufficient responses for analysis, I recommend that future studies maintain a longer duration of time allotted for firefighters to participate in the study. A longer survey participation period could have produced more results in some instances that remained unclear for my interpretations. Although the minimum number of survey responses was collected at nearly twice the requirement, a higher number could result in further saturation of the data analysis and interpretations.

I recommend that further studies incorporate individual firefighters to respond to questions and provide their own opinion in some instances. A closer examination of any



intrinsic motivation components could provide a more detailed and accurate understanding to individual adherence to NFPA 1583. Individual responses on the extrinsic motivation component could also reveal any items that promote individual firefighter adherence to any existing health and wellness policies that the department has adopted in its standard operating procedures.

### **Implications for Positive Social Change**

I sought to examine a phenomenon that directly impacts the lives of professional firefighters. The health and wellness of firefighters remains a concern for all entities involved and it remains a top priority that the paid firefighters that serve our communities maintain their health and wellness to provide services that are expected of them. The evidence provided in this research support and identify the importance of fitness through health and wellness standard protocols while illustrating that some of the elements investigated will produce significant outcomes among firefighting personnel.

The results of this study reveal that individual firefighters adhere to some of the elements of NFPA 1583 by a combination of intrinsic and extrinsic motivators. Previous research examined adherence policies to other National Fire Protection Association standards, but no such research was found on NFPA 1583 and its adherence to such policy. The potential for other fire departments to incorporate elements of NFPA 1583 is largely anticipated due to the health and wellness priority emphasized on today's modern firefighter. As hazards continue to present themselves in increasing complexity, so are the demands of individual firefighters. It is imperative that the health and wellness of the firefighters involved in the mitigation efforts maintain expected and appropriate levels of fitness to carry out the tasks that are asked of them.

The results from my study contributes to a further understanding of a phenomenon that may impact social change in the southern most region of the United States among the paid professional firefighters that serve those communities along the southern United States border. This region contains some of the hottest climates in the United States for longer periods than any other region in the state and the health and wellness of those fire personnel are a top priority. Operating in those conditions while maintaining appropriate levels of personal protective equipment, can present some challenges to the unconditioned and unfit firefighter. NFPA 1583 assists in keeping those fire personnel safe throughout the year so that during training evolutions, firefighting personnel can participate and conduct operations responsibly and effectively.

In addition to the local municipalities that serve in the some of the harshest climates, the rest of the state and United States have access to the information presented in this research. The fire service is an evolving entity and if there is a way in the form of public policy & administration to help create positive social change, then it must be presented so that others can follow suit. The evidence presented in this research made available to training officers throughout has a much larger social implication than the region identified for this research. United States firefighters may have different brands of firetrucks, gear from different manufacturers, but the services provided to the public remain the same.

The largest contribution that my study makes to positive social change is by other entities that respond to emergencies such as law enforcement agencies, emergency medical technicians, federal police and fire agencies, and other related government organizations to closely examine adherence to their health and wellness policies. A

closer look at adherence to such policies may lead to a significantly healthy and fit organization that provides services to the public. This research allows other agencies to collect and measure similar variables that can provide a further understanding to any existing policies. If no such policies are maintained, then each agency can adopt and create health and wellness language in their standard operating procedures.

### **Conclusion**

The related literature and survey results revealed that there are differences in the degree of individual firefighter adherence to elements of NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members*. These differences support the alternative hypothesis and allow for the rejection of the null hypothesis. The fire service is an industry that is involved in dangerous scenarios and firefighters present themselves in harmful environments daily. To combat these environments, professional firefighters train to become acclimated to the hazardous conditions. Firefighters continue to perish in controlled training environments which warranted the interest for this study. Adherence to NFPA 1583 *Standard on Health-Related Fitness Programs for Fire Department Members* was not well understood and there existed no prior research in this phenomenon.

The context and empirical evidence provided a further understanding to individual firefighter adherence to NFPA 1583 and relationships were analyzed and illustrated. When motivated individual firefighters adhered to NFPA 1583, more firefighters participated in exercise programs for longer durations. The survey results related to fitness policy adherence were consistent with the literature on the importance of fitness among professional firefighters. This will contribute to a healthier fire department with

the likelihood of reducing firefighter training fatalities. A fire department that places emphasis on the health and wellness of its firefighters is likely to provide a better service to the community.

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## Appendix A

**Firefighter Fitness Survey**

1. On average, I exercise \_\_\_\_ times per shift?
  - A. 0
  - B. 1
  - C. 2
  - D. 3
  
2. I participate in physical fitness activities \_\_\_\_\_ per shift:
  - A. 0-15 minutes
  - B. 15-30 minutes
  - C. 30-45 minutes
  - D. 45-60 minutes
  
3. It is mandatory for me to adhere to a fitness policy while on duty.
  - A. Yes
  - B. No
  
4. I am familiar with the some of the guidelines outlined in NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members*.
  - A. Yes
  - B. No
  
5. I enjoy exercising by myself in the gym for:
  - A. 0-15minutes
  - B. 15-30minutes
  - C. 30-45minutes
  - D. 45-60minutes
  
6. I am familiar that in NFPA 1583 the Fire Chief shall appoint a health and fitness coordinator and peer fitness trainers.
  - A. Yes
  - B. No
  - C. I don't know
  
7. My department has a fitness coordinator to help my fitness needs and requirements.
  - A. Yes
  - B. No

8. My department has \_\_\_\_\_ fitness trainers as identified in NFPA 1583:
  - A. 0-5 trainers
  - B. 6-10 trainers
  - C. 11-15 trainers
  - D. 16-20 trainers
  
9. I choose to exercise with other firefighters:
  - A. 0-15 minutes
  - B. 15-30 minutes
  - C. 30-45 minutes
  - D. 45-60 minutes
  
10. I am familiar that in NFPA 1583 my fire department shall conduct fitness assessments for each firefighter.
  - A. Yes
  - B. No
  - C. I don't know
  
11. I am required to complete an annual fitness assessment for my job while on duty.
  - A. Yes
  - B. No
  
12. I am familiar that in NFPA 1583 my department will implement an exercise and fitness training program.
  - A. Yes
  - B. No
  - C. I don't know
  
13. I have an individualized fitness program provided to me by my department's health and fitness coordinator and trainers:
  - A. Yes
  - B. No
  
14. My department promotes individualized health education as mentioned in NFPA 1583 for health and fitness.
  - A. Yes
  - B. No
  
15. Individual firefighters are required to exercise:
  - A. 0-15min per shift
  - B. 15-30min per shift
  - C. 30-45min per shift
  - D. 45-60min per shift

16. My department has adopted some of the described elements of NFPA 1583 in its health and fitness program.
- A. Yes
  - B. No
17. It is a priority for me to adhere to NFPA 1583 when participating in a fitness program.
- A. Yes
  - B. No
18. How many years have you been a professional firefighter?
- A. 0-5 years
  - B. 5-10 years
  - C. 10-15 years
  - D. 15-20+ years
19. What rank do you currently hold in your fire department?
- A. Cadet
  - B. Firefighter
  - C. Driver
  - D. Lieutenant
  - E. Captain
  - F. Chief
20. What is your current age?
- A. 18-26
  - B. 27-35
  - C. 36-44
  - D. 45-53
  - E. 54-62