KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

COLLEGE OF HEALTH SCIENCES

SCHOOL OF PUBLIC HEALTH

DEPARTMENT OF HEALTH POLICY, MANAGEMENT AND ECONOMICS

OCCUPATIONAL RELATED INJURIES AND DISABILITIES AMONG OPERATIONAL FIRE FIGHTERS IN GHANA

BY

BENJAMIN OSAFO CARLIS-PAITTOO

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A THESIS SUBMITTED TO THE DEPARTMENT OF HEALTH POLICY, MANAGEMENT AND ECONOMICS, SCHOOL OF PUBLIC HEALTH, COLLEGE OF HEALTH SCIENCES IN PARTIAL FULFILLMENT AS A REQUIREMENT FOR THE DEGREE OF

MASTER'S IN PUBLIC HEALTH, HEALTH SERVICES PLANNING AND MANAGEMENT

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DECLARATION

I hereby do declare that except for references to other people's work which have been duly acknowledged, this piece of work is my own composition and neither in whole nor in part has this work been presented for the award of a degree in this university or elsewhere.

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ABSTRACT

Fire fighters experience inordinate numbers of line-of duty (LOD) injuries due to occupational diseases, and forced retirements. There seems however to be no improvement in terms of policies and structures to curtail this challenge. The main objective sought to assess the triggers and types of injury and disabilities and their implications on operational fire fighters in Ghana. The study was descriptive crosssectional study. The study involved 245 fire personnel drawn from larger urban fire stations (Greater Accra, Central region, Western region and Ashanti regional fire commands). Data was collected using structured questionnaires and in-depth interview guides. Analysis of data was done using SPSS version 22 and this involved descriptive statistics and testing of associations. Multivariable logistic regression analysis was done to adjust for the confounding effects of the independent variables and to estimate the odds of experiencing injury among fire personnel. All statistical tests were conducted at significance level of $p<0.05$. The study showed a high level of injury among firefighters (51% of the respondents in this study admitted they had ever experienced injury) and most of these injuries were minor. Three was however poor management of injury with only less than 10% being catered for by the service. Majority of interviewed fire fighters had not had safety training, lacked surveillance systems, and there were inadequate injury tracking programmes suggesting low level of preparedness in injury prevention and disability care. Lack of health safety training among firefighters increased the odds of experiencing injury (AOR=2.82; 95% CI= 1.4, 5.8). This study found a high level of injury but a low level of preparedness in dealing with injury and

disability in the GNFS. Efforts should be scaled up to ensure adequate preparedness in terms of equipment and training, lack of which has shown to
increase experience of injuries.

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DEFINITION OF TERMS

Aviation Safety Reporting System (ASRS): ASRS captures confidential reports, analyzes the resulting aviation safety data, and disseminates vital information to the aviation community.

American Public Power Association (APPA): is the service organization for the more than 2,000 U.S. community-owned electric utilities that serve more than 47 million Americans. APPA was created in September 1940 to represent the common interests of these utilities. Today, APPA's purpose is to advance the public policy interests of its members and their consumers and provide member services to ensure adequate, reliable electricity at a reasonable price with the proper protection of the environment.

Accident Prevention: Accident prevention includes all measures taken in an effort to save lives, escape from injury, lessen the degrees of injury, reduce loss of properties, treatment and compensation costs, production and time loss, and morale loss of the concerned organization.

American Medical Association (AMA): The American Medical Association (AMA), founded in 1847 and incorporated in 1897,is the largest association of physicians—both MDs and DOs—and medical students in the United States. The AMA's stated mission is to promote the art and science of medicine for the betterment of the public health, to advance the interests of physicians and their patients, to promote public health, to lobby for legislation favorable to physicians and patients, and to raise money for medical education.

Crew Leader/Crew Member: The Fire Crew Member or Leader is responsible for providing firefighting services by carrying out fire line duties and maintaining firefighting equipment.

Casualties: a person killed or injured in a war or accident.

Diaspora: is a scattered population with a common origin in a smaller geographic locale. Diaspora can also refer to the movement of the population from its original homeland.

Disabilities: Disability is the consequence of an impairment that may be physical, cognitive, mental, sensory, emotional, developmental, or some combination of these. A disability may be present from birth, or occur during a person's lifetime.

Emergency Medical Services (EMS System): The arrangement of personnel, facilities and equipment for the effective and coordinated delivery of urgent medical services as required in the prevention and management of incidents which occur either as a result of a medical emergency or of an accident, natural disaster or similar situation.

Emergencies: An emergency is a situation that poses an immediate risk to health, life, property, or environment.

Fire Station: is a structure or other area set aside for storage of firefighting apparatus such as fire engines and related vehicles, personal protective equipment, fire hoses and other specialized equipment.

Federal Fire Prevention and Control Act (FFPCA): Federal Fire Prevention and Control Act of 1974 was an attestation proclaiming fire as an undue burden affecting every American while presenting a public health and safety premonition of disproportionate dimensions.

Fire Fighter (FF): A firefighter (also known as a fireman or firewoman) is a rescuer extensively trained in firefighting, primarily to extinguish hazardous fires that threaten property and civilian or natural populations, and to rescue people from dangerous situations, like collapsed or burning buildings or crashed vehicles.

Ghana National Fire Service (GNFS): The Ghana National Fire and Rescue Service (GNFRS) is an agency under the Ghanaian Ministry of the Interior, constituting

Ghana's nationwide fire service. It was established as the Ghana National Fire Service (GNFS) by the GNFS Act of 1997 (Act 537) with a broad objective of prevention and management of undesired fires and other related matters.

Hazardous Materials: Dangerous/Hazardous goods are solids, liquids, or gases that can harm people, other living organisms, property, or the environment. They are often subject to chemical regulations.

Health & Safety: Occupational safety and health (OSH) also commonly referred to as occupational health and safety (OHS) or workplace health and safety (WHS) is an area concerned with the safety, health and welfare of people engaged in work or employment.

High Reliability Organizations (HROs): Associations or groups whose production, services, or technologies have inherent potential for very hazardous or severe consequences of errors, yet have maintained a high record of safety over long periods of time.

Injury: Injury is damage to the body. This may be caused by accidents, falls, hits, weapons, and other causes. Major trauma is injury that can potentially lead to serious outcomes.

Incident Ground: Term referred to within the Fire Service when describing a property, house, warehouse or building that is on fire or has a fire within that structure.

International Association of Fire Fighter (IAFF): is a labor union representing professional firefighters in the United States and Canada. The IAFF was formed in 1918 and is affiliated with the AFL-CIO in the United States and the Canadian Labour Congress in Canada.

Line-of-Duty: A line of duty death (LODD) is a death in the fire service while on duty at an emergency or drill.

Near-miss: A near miss is an unplanned event that did not result in injury, illness, or damage – but had the potential to do so. Only a fortunate break in the chain of events

prevented an injury, fatality or damage; in other words, a miss that was nonetheless very near.

NFPA 1500 Standard: NFPA 1500 specifies the minimum requirements for an occupational safety and health program for fire departments or organizations that provide rescue, fire suppression, emergency medical services, hazardous materials mitigation, special operations, and other emergency services.

National Fire Incident Reporting System (NFIRS): is a system established by the National Fire Data Center of the United States Fire Administration (USFA), a division of the Federal Emergency Management Agency. The System was established after the 1973 National Commission on Fire Prevention and Control report, America Burning, led to passage of the Federal Fire Prevention and Control Act of 1974 (P.L. 93-498), which authorizes the USFA to gather and analyze information on the magnitude of the Nation's fire problem, as well as its detailed characteristics and trends. The Act further authorizes the USFA to develop uniform data reporting methods, and to encourage and assist state agencies in developing and reporting data.

National Aeronautics and Space Administration (NASA): is the United States government agency responsible for the civilian space program as well as aeronautics and aerospace research.

National Occupational Research Agenda (NORA): is a partnership program to stimulate innovative research and improved workplace practices. Unveiled in 1996, NORA has become a research framework for NIOSH and the nation. Diverse parties collaborate to identify the most critical issues in workplace safety and health. Partners then work together to develop goals and objectives for addressing these needs.

National Institute for Occupational Safety and Health (NIOSH): is the U.S. federal agency that conducts research and makes recommendations to prevent worker injury and illness.

Paramedic Staff: A paramedic is a health care professional, predominantly in the pre-hospital and out-of-hospital environment, and working mainly as part of emergency medical services (EMS), such as on an ambulance.

Personal Protective Equipment (PPE): Personal protective equipment (PPE) refers to protective clothing, helmets, goggles, or other garments or equipment designed to protect the wearer's body from injury or infection. The hazards addressed by protective equipment include physical, electrical, heat, chemicals, biohazards, and airborne particulate matter.

Polychlorinated Biphenyl (PBs): A polychlorinated biphenyl is a synthetic organic chemical compound of chlorine attached to biphenyl, which is a molecule composed of two benzene rings.

Risk: is potential of losing something of value. Values (such as physical health, social status, emotional well being or financial wealth) can be gained or lost when taking risk resulting from a given action, activity and/or inaction, foreseen or unforeseen.

Risk can also be defined as the intentional interaction with uncertainty.

Risk Assessment: is the process where you: Identify hazards. Analyze or evaluate the risk associated with that hazard. Determine appropriate ways to eliminate or control the hazard.

Road Traffic Collision (RTC): An accident involving a mechanically-propelled vehicle on a road or other public area which causes: Injury or damage to anybody - other than the driver of that vehicle.

Self-Contained Breathing Apparatus (SCBA): A self-contained breathing apparatus, or SCBA, sometimes referred to as a compressed air breathing apparatus (CABA), or simply breathing apparatus (BA), is a device worn by rescue workers, firefighters, and others to provide breathable air in an "Immediately Dangerous to Life or Health" atmosphere (IDLH).

Severity: Value or weighting placed on an injury by an organization

Training Officer: A Field Training Officer (FTO) is an experienced or senior member of an organization who is responsible for the training and evaluation of a junior or probationary level member. The role is used extensively in law enforcement, fire departments, and emergency medical services.

Training: Training is teaching, or developing in oneself or others, any skills and knowledge that relate to specific useful competencies. Training has specific goals of improving one's capability, capacity, productivity and performance.

ACRONYMS/ABBREVIATIONS

ASRS:	Aviation Safety Reporting System
APPA:	American Public Power Association
AMA:	American Medical Association
CAD:	Coronary Artery Disease
EMS:	Emergency Medical Services
EMR:	Emergency Medical Response
FFPCA:	Federal Fire Prevention and Control Act
FF:	Fire Fighter
GNFS:	Ghana National Fire Service
HROs:	High Reliability Organizations
IAFF:	International Association of Fire Fighter
KNUST:	Kwame Nkrumah University of Science and Technology
LMIC:	Low and Middle-Income Countries
NFIRS:	National Fire Incident Reporting System
NIST:	National Institute of Standards and Technology
NASA:	National Aeronautics and Space Administration
NORA:	National Occupational Research Agenda
NVTI:	National Vocational Training Institute
NIOSH:	National Institute for Occupational Safety and Health
PPE:	Personal Protective Equipment
PMR:	Proportional Mortality Rates
PBs:	Polychlorinated Biphenyls
RTCs:	Road Traffic Collisions
SCBA:	Self-Contained Breathing Apparatus
SMRs:	Standardized Mortality Ratios

SIRs: Standardized Incidence Ratios **YCD:** Years cost due to Disabilities

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DEDICATION

I dedicate this dissertation to God Almighty for his wisdom and direction, my supervisor, my family and friends for their immense encouragement and support, and including my mother Mrs. S.L.A Paittoo and my wife Victoria Adjoa Owusuwaa.

CHAPTER ONE INTRODUCTION

1.0 Background Information

Every year in Ghana, over 100 fire-fighters are injured and most get permanently disabled while fighting fires, training, and responding to medical, technical, and hazardous emergencies. Fire fighting deaths and injuries significantly impact on the victims' families, departments, and communities.

In 2011, the Ghana National Fire Service (GNFS) suffered two line-of-duty deaths and numerous on duty injuries. These casualties like the thousands of other fire service in the Diaspora, occurred despite decades of improvements in fire fighter safety, health, training, protective gear, and equipment. It is unfortunate to note that, the GNFS currently does not have any well-equipped emergency medical care facility for the injured personnel. Indeed, as *Kobusingye, et al (2004)* commented; that emergencies do occur everywhere whether there are well established emergency medical services or not. There is therefore the need to set-up a well-established emergency unit which is cost- effective. A well-established emergency unit should permeate the national, regional and community levels *(Kobusingye, et al., 2004).*

Many researchers contend that a better understanding of how and why these fatalities and injuries occur can help identify corrective actions that will save lives *(Karter & Molis, 2011, p. 1; Hofmannn & Stetzer, 1998).* Consider the following example: "If the Fire Service and safety researchers have comprehensive, consistent, and accurate information about who is being injured, how they are being injured, and what types of injuries occur, then these injuries can be prevented" *(FIRST, Drexel School of Public Health Website, n.d., p.1).* An often-quoted and poignant remark from Retired Chief Vincent Dunn echoes this consensus; "In order for a fire fighter to survive the danger

of fire fighting, he or she must know how other fire fighters have died" *(Hoff & Kolomay, 2003, p. 1)*. To that end, this research seeks to understand the underlying factors that precipitate injuries and disabilities to strengthen existing preventive and safety measures among fire fighters in Ghana.

Reviewing the data held by the GNFS provided an insight into the location and nature of injuries experienced by the Firefighters. Comparing the findings of the Fire Service with that of the findings held internationally into firefighter injuries was undertaken. This was in direct comparison with international research which indicated emergency incident injuries were more common. The nature of injuries were similar regardless of what country and what task were being carried out.

Identifying work environments, for instance, and whether they exist as a significant contributing factor to the frequency of injuries could further identify injury causation, appliance design, job description, training design and delivery, improved near-miss and injury reporting programmes, decision -making in standard operating procedures, policy and procedure, and the logistics provided to undertake the role of firefighting in an injury consciences era.

Generally perceived as a high-risk vocation in a hazardous work environment, firefighter injuries are also understood as reflecting the vast role they undertake within society. With injuries to career firefighters costing the GNFS millions of cedis each year the incentive for top management strategy to reduce injuries occurring forms part of their job performance and the overall goal to reduce costs in this field.

Against this background, the topic of assessment of firefighter injuries, and, consequent disabilities prevention is one that can encompass many areas of injury data. A further look at the correlation between length of service, age, educational background, location

and injury frequency of firefighters may indicate again, further injury prevention strategies with a number of potential changes to the approach taken.

In order to determine significant life-saving areas where reduction in accidents can occur, an understanding of specific statistics is required. Again, having identified the location where the majority of injuries occur, the influence to change can reduce the accident frequency rate, severity and ultimately cost. Key factors in identifying accident trends are the sources^; of accident data and their accuracy.

The key issue is that the GNFS does not collect on-duty injury or near-miss data for analysis or reporting and therefore cannot identify corrective actions to reduce fire fighter injury and death in the Department. A real obstacle facing the analysis of injury problem was the lack of data, which, if available, could lead to effective corrective action. Additionally, previous injury records were not maintained in a form that led to effective analysis. The purpose of this research is to generate baseline data and access the level of preparedness in dealing with injuries and disabilities in the GNFS.

1.1 Problem Statement

Fire fighters work hard each and every day, protecting and serving our citizens by answering varying calls for help-a call to save lives and yet are exposed to risk of injuries, near miss and disabilities. Some of the calls may be to suppress fire and save lives jeopardized by smoke and flame. It may be a response to hazardous materials incident, a structural collapse or other operation event. The response may be for emergency medical assistance and transport to the hospital, with potential exposures, for instance to a host of infectious diseases.

More often than not, fire fighters have little idea about the identity of many of the materials they are exposed to or the health hazardous of such exposures whether they

are chemical, biological or particulates. Nevertheless, fire fighters and emergency medical responders continue to respond to the scene and work immediately to save lives and property damage without regard to the potential health hazardous that may exist. It is unfortunate to emphasize, among others, that a fire emergency has no engineering controls or occupational safety and health standards to reduce the effect of irritating, asphyxiating or toxic gases, aerosols, chemicals or particulates. It is uncontrollable on environment that is fought by fire fighters using heavy, bulky and often time's inadequate personal protective equipment and clothing.

One key issue that cannot be over emphasized is that an occupational disease takes years to develop. It is, however, the result of a career of responding of fire and hazardous materials incidents; it is generally caused by breathing toxic fames, biological agents, and particulate matter on the job, and it, as well, the response to continuous medical runs or extricating victims at accidents. Some health effects are immediate while others may take years and even decades to develop *(Karter and Moris, 2007).*

It is paramount to state that the provision of fire suppression and emergency medical services entails sporadic high levels of physical exertion, uncontrolled environmental exposures, and psychological stress from observing intense human suffering. Fire fighters experiences inordinate numbers of line-of duty (LOD) injuries due to occupational diseases, and forced retirements *(Moore-Merrel, 2008).* Year after year, there are notable advancements in the fire industry. These advancements range from building code improvement to high rise buildings, from better personal protective gear to technologically advanced apparatus. Many profound advances have also been made in both laws and programmes designed to improve workers safety and health for all

workers in Ghana (*ref. Fire Safety Regulation, LI 1724*). In spite of these laws and improvement mentioned, scores of fire fighters are injured in the line of duty each year.

It is important to note that, the rate of fire outbreaks coupled with its attendant injuries and disabilities among personnel of the Ghana National Fire Service (GNFS) cannot be underestimated. More often than not, operational fire fighters got injured or died during the course of performing their stated tasks, roles and responsibilities; thus fire ground operations, training, and road traffic extrication (RTA). Yet, there seems to be no improvement in this direction after some form of attempts by officials and management to curtail this challenge.

In the year 2010 a fire woman fell and died from a high rise building during a simulation exercise. The main cause was attributed to obsolete equipment used for the drills. Some fire fighters were reported to have been attacked by reptiles during a bush fire in a Metropolitan Fire Station in the Brong-Ahafo Region, Ghana.

Two fire fighters had their feet damaged by leaked acidic products in a warehouse blaze in Accra Central. Attributable cause was identified to be non-standardized boots or footwear worn by the fire fighters. Some other personnel also continue to suffer from long term occupational related respiratory diseases and so on.

Another key challenge, on the other hand, is that the Ghana National Fire Service does not have any surveillance system to collect on-duty injuries or near –misses and disability data to inform safety and preventive interventions and therefore cannot identify corrective actions to reduce fire fighter injury and death in the organization.
It is to be noted that, if the risks and contributing factors for fire fighters LOD injuries are to be fully understood, empirical evidence on the sequence of events unfolding at and around particular fire incidents and emergency situation must be documented.

While long-term prevention, health promotion, and technological advancements certainly equip fire fighters with individual and sometimes unit level tools to reduce on-duty risk before an accident occurs, far less research has examined the influence that the interaction of these factors and more dynamic , situation-specific elements have on fire fighters LOD injuries during any fire operations in this vein, this research seeks to assess and consequently, examine the occupational related injuries and disabilities among operational fire fighters in Ghana, with the view to promote sustainable safety and preventive, precautionary measures, programmes and policies.

1.2 Significance of the Research

1. Findings from this research is expected to assist management of the Ghana National Fire Service to institute the required and appropriate health and safety measures and / or Injury and Disability Prevention Plan (IDPP).

2. Findings from the research would expand the limited corpus of knowledge, awareness and literature in the area of fire fighter injuries and disabilities, in Ghana.

3. Findings from the research could also stimulate other curious minds to further replicate the research in other emergency response organisations or perhaps as an expanded national project / research incorporating contemporary issues on national emergencies and disaster management.

1.3 Research Questions

Main Question;

What types of injuries and disabilities are found among fire-fighters in Ghana?

Sub Questions;

i. What are the most common type of injuries and disabilities experienced by fire fighter in Ghana?

ii. How do these injuries and disabilities occur?

iii. What is the level of preparedness of the GNFS in managing injury among fire fighters?

iv. What factors do influence injury or near-miss reporting?

1.4 Objectives

General Objective

To assess the triggers and types of injury and disabilities and their implications on operational fire-fighters in Ghana.

Specific Objectives

i. To identify the most common triggers and types of injuries and disabilities experienced by fire fighters.

ii. To determine how these injuries and disabilities occur iii. To assess the level of preparedness of the GNFS in managing injury among fire fighters iv. To determine the factors which influence injury or near-miss reporting system

1.5 Conceptual Framework

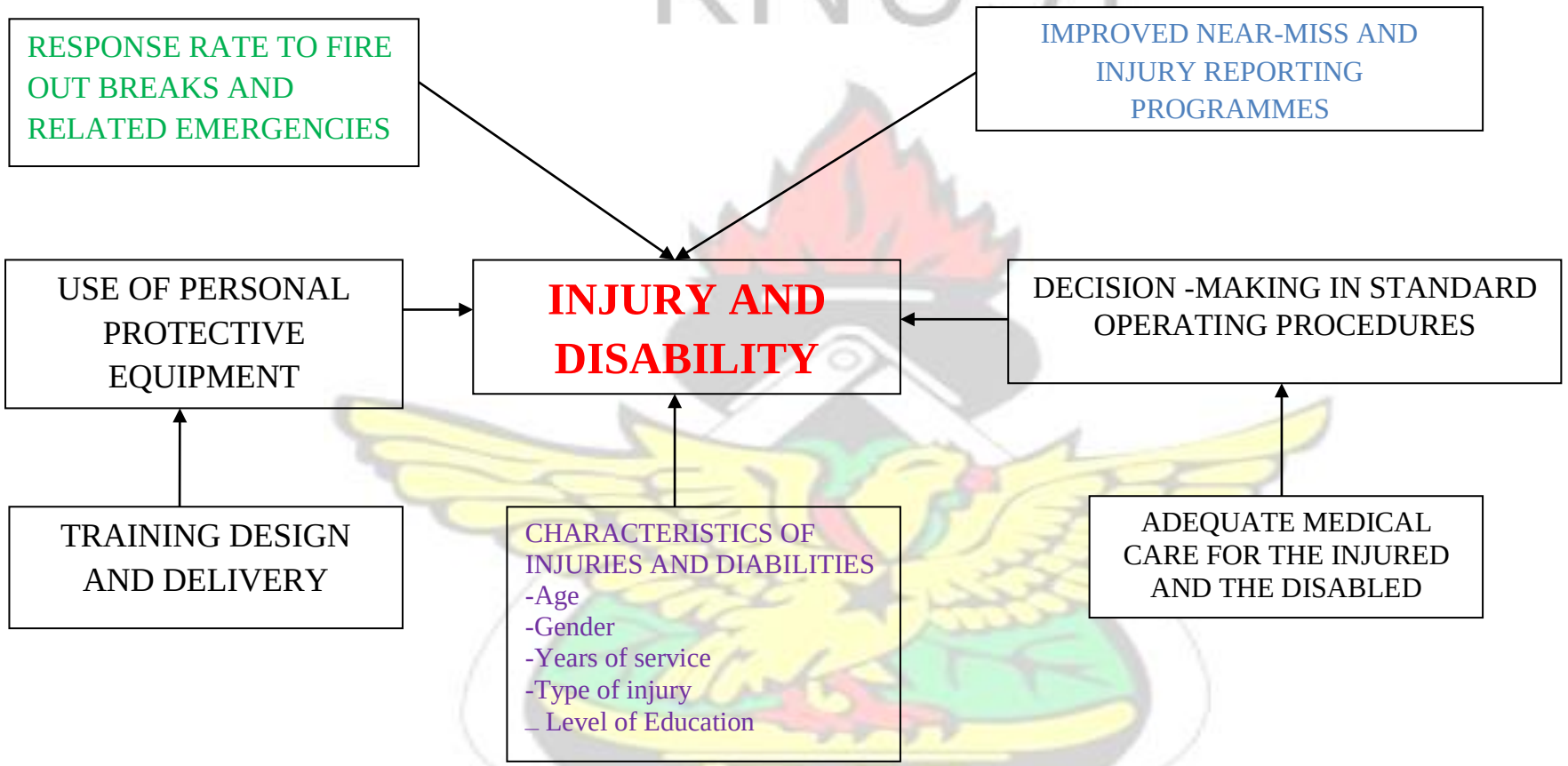


Figure 1.1: Conceptual Frame Work, Source: Author's construct

Explanation of the Conceptual Framework

The Ghana National Fire Service (GNFS) recommends periodic assessment of health status among operational fire fighters, in Ghana. It is a conception that, the age, gender of an individual, years of service served and types of injuries impacts on their performance and, consequent, injuries and disabilities. So it is with experience, provision of adequate logistical support, and medical care, regular training schedules and performance standards or guidelines. All these put together represent injury preventive planning. As demonstrated in Fig 1.1 above, the socio-demographic state of the fire fighter, together with adequate provision and growth of efficient injury and near-miss reporting program, use of personal protective equipment (PPES'), holistic standard operating procedures, response rate to emergencies, adequate medical care as well as the development and facilitation of trained and motivated fire fighters, not compromising on the provision of performance protocol, thus define the establishment of Injury and Disability Prevention Plan (IDPP).

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter presents a review of previous literature and its relevance to this particular study. Literature is reviewed from journal articles, newspapers, unpublished works and other electronic sources.

2.1 Overview

Injury and illness are two work- related risks among firefighters, as well as, other Emergency Medical Services (EMS) workers. A pioneering study by *Maguire et al (2005)* using Department of Labor – United States records indicates that occupational

injury rates were higher in EMS workers in 2000 than for workers in any other industry. In an earlier study, the same authors found that the occupational fatality rate for EMS workers was more than twice the national average *(Maguireet al., 2002).* This research reports the systematic review of the existing literature to determine the circumstances, characteristics, and extent of occupational injury and illness among fire-fighters and the EMS workforce.

NFPA 1500 Standard on Fire Department Occupational and Health Programme (2007) is the standard at which all fire departments compare and measure their own organization as regards to safe operations. This standard is considered "the golden standard" due to the importance of the subject that it covers. Within this standard, Section 4.10 Accident Prevention, the framework is laid out for the prevention of injuries from occurring. Detailed course of action is defined and directed to set policy in place by the department for the safety of firefighters. It is due to this standard that much research and attention is paid to accident prevention.

2.2 Firefighter Injury and Disability Trends

Firefighters perform EMS functions in many parts of the country, especially in urban areas. Standardized reporting systems were mandated by the Federal Fire Prevention and Control Act of 1974 *(P.L. 93-498)* which authorized the National Fire Data Center in the United States Fire Administration (USFA) to gather and analyze information on fires and fire department operations, including injury and later illness. In addition, reports on patterns of firefighter injury have grown in detail and sophistication since their launch in 1986 (USFA, 2006); Finally, the National Fire Protection Association (NFPA) has been conducting annual analyses of these data since 1977 (NFPA, 2006). As a result, the information collected and analyzed regarding firefighters is relevant to the present topic. However, by their design, much of the information from these

systems focuses upon fire-fighting activities, and information on EMS-related illness and injury is limited.

2.2.1 Types of Injuries

Firefighters engage in occupation that is characterised by high-stress, high-risk and low-control of the job-related tasks *(Landen and Wang, 2010). Guidotti and Clough (1992: 152)* outline the occupational health and safety risks faced by firefighters:

Occupational hazards experienced by firefighters may be categorized for convenience as physical, thermal and ergonomic, chemical, and psychological. In fact, the level of exposure experienced by a firefighter in a given fire depends on what is burning, the combustion characteristics of the fire, the structure on fire, the presence of nonfuel chemicals, the measures taken to control the fire, the presence of victims requiring rescue, and the position or line of duty held by the firefighter while fighting the fire.

Sources of work-related stress for instance, for firefighters include physical, psychological and psychosocial hazards *(Comcare, 2008).* In addition to the risks to physical health, the dangerous nature of firefighting - suppressing fires and exposure to dangerous substances - also entails considerable anxiety that can produce stress reactions in individuals. Attendance at traumatic incidents can result in psychological distress. Moreover, psychosocial aspects such as the 'design, organization and management of work and its social and environmental context that can cause psychological, social or physical harm' *(Comcare, 2008: 8).* The extension over time of firefighter duties to include not only the traditional role of fire prevention and suppression, but also attendance at motor vehicle accidents, rescue operations, and emergency medical response (EMR) has exposed firefighters to additional types of stress.

In a special 2005 report, the NFPA released an analysis of U.S. firefighter fatalities due to sudden cardiac death (Fahy, 2005). Of 1,006 total fatalities for the 10-year period, 440 (44%) were attributed to sudden cardiac death and 47 (11%) occurred during the performance of EMS activities. The most recent NFPA analysis *(Fahy, 2006*) analyzed 87 total firefighter deaths, 47 (54%) of which were due to sudden cardiac death. It was not possible from this report to determine how many were related to EMS activities.

Fangchao et al. (2005) examined mortality in a cohort of Florida firefighters, noting increased risk of mortality for males from breast, bladder, and thyroid cancers and increased risk of cardiovascular disease mortality in female firefighters. Based upon an analysis of nine years of data from the National Health Interview Survey, *Lee et al., (2004)* reported that firefighters age 30 to 39 face a significantly greater risk of hospitalization relative to other employed men in the same age group. *Haas et al., (2003)* reviewed 17 studies that reported calculated standardized mortality ratios (SMRs) for firefighters. These authors examined time-dependent mortality effects for all causes, and, specifically, coronary artery disease (CAD), cancer and respiratory deaths. In contrast to other studies, their time-series study failed to identify any increased mortality with increasing tenure for all-cause mortality or any specific cause. Further, the authors identified many causes of death for which firefighters' SMRs were less than one, indicating decreased mortality for those causes.

Firefighters have one of the most dangerous occupations and have higher than average rates of workplace deaths and injuries. They perform physically demanding work, encompassing multiple fire ground tasks: fire attack, search and rescue, exterior ventilation, and overhaul activities. Firefighters also respond to emergency situations and are frequently first on scene for emergency medical response (EMR), motor vehicle accidents, and other emergencies such as floods, earthquakes, cyclones and terrorism *(Clarke and Zak, 1999).* Overexertion and occupational stress have been linked to

increased risk of stroke and myocardial infarctions and a leading cause of on-duty fatalities for firefighters is heart attack *(Varvel et al., 2007).*

In addition to the inherent physical demands of the job, firefighters are also exposed to numerous hazardous materials, including, asbestos, carbon monoxide, hydrogen cyanide, nitrogen dioxide, sulphur dioxide, hydrogen chloride, aldehydes, benzene and diesel fumes *(Guidotti and Clough, 1992).* Exposure to dangerous substances has resulted in a higher likelihood of firefighters developing a variety of cancers. *Guidotti and Clough (1992)* explain that the introduction of protective equipment has made firefighting safer but has also resulted in an increase in physical exertion due to the increased weight of clothing and equipment. Exposure to radiant heat can result in skin changes such as erythema and telangiectasia.

A brief consideration of some international statistics demonstrates higher fatality rate of firefighters. A study of workers compensation records in the United States between 1992 and 1997 revealed that the average workplace fatality rate for firefighters was 17 per 100,000 employed compared to 5 fatalities per 100,000 employed for all workers, making firefighters more than three times as likely to be fatally injured at work *(Clark and Zak, 1999).* The most common causes of workplace fatalities during this period were fires and explosions (42 per cent) and transportation incidents (35 per cent). Of those firefighters who lost their lives fighting fires two thirds died fighting building or structure fires, while forest or bush fires accounted for around one-quarter *(Clarke and Zak, 1999).*In the UK, occupational fatalities reported to the Health and Safety Executive (HSE) indicated a rate of 7.4 to 8.5 fatalities per 100,000 firefighters employed. However, the data excludes work-related traffic accidents and heart attacks *(Fire Brigades Union, 2008).*

Clarke and Zak (1999: 6) emphasized that: Fatality counts are important in evaluating hazardous jobs because the number of workers killed indicates the magnitude of a safety

problem for a group of workers. In addition to fatalities, a number of adverse health issues are associated with firefighting, including: injuries due to burns and falls; respiratory and cardiovascular disease. In the US, there were 70,090 firefighter injuries in 2011. Of these 43.5 per cent occurred during fire ground operations, 21.3 per cent were during attendance at non-fire emergencies, 5.5 per cent were while responding to or returning from an incident, 10.7 per cent were during training activities and 19.0 per cent were during other on-duty activities *(Karter and Molis, 2012). Clarke and Zak (1999)* reported that the leading non-fatal event between *1992* and *1999* in New York was contact with an object or equipment (19 per cent of nonfatal accidents), while overexertion accounted for 23 per cent of non-fatal events in California over the same period.

Walton et al., (2003) examined workers' compensation data for firefighters in Illinois between 1992 and 1999 and found that the most common injuries were strains or sprains (38 per cent), overexertion (33 per cent), burns (27 per cent) cuts or lacerations (22 per cent) and slips, trips or falls (13 per cent).A study of 1,500 Polish firefighters employed between 1994 and 1997 found that 40 per cent of injuries occurred during compulsory training sessions and 24 per cent happened during emergency operations *(Szubert and Sobala, 2002). Szubert and Sobala (2002)* did not find any link between injuries and the age of firefighters but found that the duration of time off work increased by 20 per cent with age. In 2011, firefighters in the United States recorded 9,000 exposures to infectious diseases and 23,400 exposures to hazardous materials *(Karter and Molis, 2012).*

2.3 Common triggers and types of injuries and disabilities experienced by fire fighters

It is to be noted that, the U.S. Fire Administration's (USFA) voluntary-enrollment National Fire Incident Reporting System (NFIRS) comprises the largest information

database used for analysis in most academic and government publications on firefighter injuries and fatalities. Module 5 of the current NFIRS Version 5.0, the Fire Service Casualty Module, includes a firefighter injury reporting form (NFDC 2008). However, the majority of papers using data from this system examine firefighter fatalities and the risk of death associated with coronary heart disease, structure related trauma, and the risk differences for a variety of factors between career and volunteer firefighters *(CDC 2006, Hodous 2004, Kales 2003).* Few studies to date have attempted to quantify incident-level risk factors for firefighter injury using NFIRS data (Fabio 2002). The National Fire Protection Agency (NFPA) Survey of Fire Departments for U.S. Fire Experience is the industrial counterpart to NFIRS annual data and projects responses from 2,500-3,500 departments into national figures by weighting the results to adjust for the proportion of U.S. population represented by community size. NFPA reports provide annual national estimates of injuries by cause, type of duty, and number of injuries per department by population of community protected *(Karter 2007).* Conclusions drawn from either of these datasets are confined by study designs that by necessity exclude certain fire incidents. Thus, NFIRS' voluntary reporting system and NFPA's survey projections give the most extensive accounts of U.S. firefighter injuries, but these estimates are still only partially complete.

Presently, academic literature that attempt to identify and assess factors contributing to firefighter LOD injuries tend to focus on broad risk categories that can be studied using a general knowledge of firefighters' physical duties and potentially hazardous fire ground exposures. These papers, which usually address overall firefighter fitness or equipment use, emphasize the fact that public safety depends on the general health of firefighters and medical first responders and that effective equipment use can prevent certain types of injury *(Soteriades 2005).* Reduced firefighter fitness and cardiovascular health have so far received the most attention as contributing factors to

"adverse employment events" including on-duty injury and disability *(Kales 2002, Soteriades 2002-2008, Sothmann 2004).* A few studies of firefighter equipment and ergonomics have confirmed the use of specific uniforms and vehicle restraints in preventing LOD burn and motor vehicle injuries, as well as identified emergency rescue tasks that cause the most musculoskeletal strain *(Becker 2003, Lavender 2000, Prezant 2000).* Likewise, several smaller analyses have affirmed the role that the close-knit structure of a fire company plays in shaping various health promotion attitudes *(Elliot 2004 & 2007, Moe 2002).* By addressing issues such as hearing loss, eating habits, and psychological stress in the context of unit-level resources and outcomes, such papers come closer to realizing the occupational experience of many firefighters but are still somewhat removed from line-of-duty incidents *(Bacharach 2008, Beaton 1998, Hong 2008, Kales 2001, Tak 2007).* Studies of breathing apparatus use during overhaul come nearest to documenting the risks of lung injury during specific incident conditions, but these like the majority of academic papers examine a highly localized sample population *(Austin 2001, Burgess 2001).*

Each occupation has inherent dangers that affect the health and well-being of its employees and operation of the organization. For example, miners are susceptible to underground shaft collapse, oxygen depletion, and toxic gases (Bureau of Labor Statistics, 2007). Also, employees in the poultry industry are prone to nerve and muscle damage in their hands due to the many cutting motions used to dissect chickens *(Hall, Alexander, and Ordonnez, 2008).* Not unlike other occupations the fire service is prone to certain injuries and illnesses. According to both Karter and Molis (2009), and the National Fire Protection Association (NFPA) (2004), the majority of firefighter's injuries consisted of sprains, strains, and muscular pains whether they occurred during fire ground operations or non-fire ground operations. For example, sprains, strains, and muscular pains accounted for 45.1 percent of firefighters' injuries during fire ground

operations and 57.8 percent of firefighter's injuries during non-fire ground operations (National Fire Protection Association, 2004).

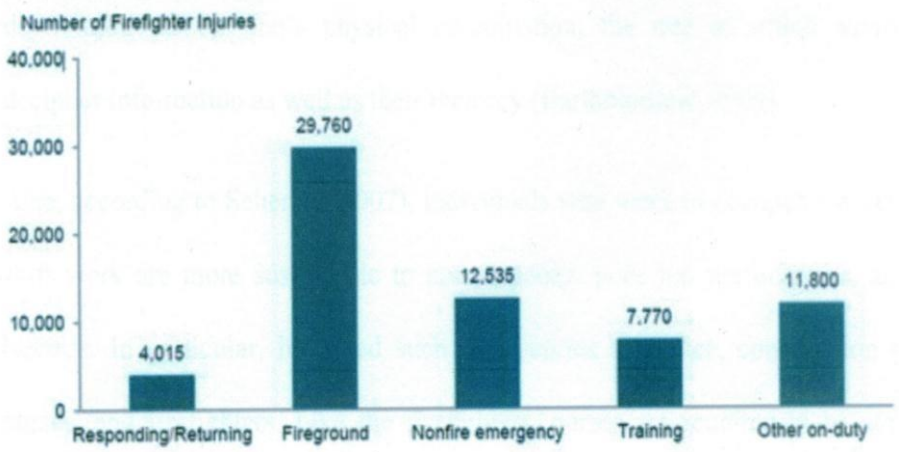


Figure 2.1: Firefighter injuries by type of duty

Source: NFPA Report, 2013

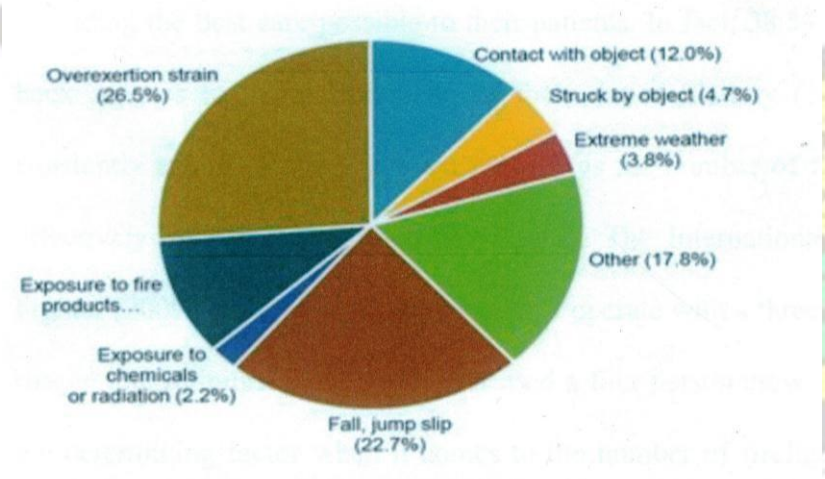


Figure 2.2: Fireground injuries by cause

Source: NFPA Report, 2013

Most sprains, strains, and muscular pains and can be attributed to overexertion, carelessness and lack of focus on the fire ground *(Karter and Molis, 2009). Glazner (1996)* stated that injuries sustained by firefighters were more likely to occur at meal time or between the hours of 18:00 and 24:00. This can be attributed to a disruption of eating pattern or fatigue due to sleep deprivation. According to Dr. Kavey, sleep

deprivation affects one's physical coordination, the rate at which someone can decipher information as well as their memory *(Bartholomew, 2009).*

Also, according to Schenck (2007), individuals who work in occupations that require shift work are more susceptible to complacency, poor job performance, and safety hazards. In particular, he noted such occupations as police, construction workers, nurses, and firefighters. Like the firefighters, nurses are required to be available 7 days a week and 24 hours a day. Nurses also respond and operate as a team when a patient is in crisis, which quite often involves physical exertion on the part of the nurse. Not unlike firefighters, nurses often overexert themselves when it comes to providing the best care possible to their patients. In fact, 38 % of nurses experienced back injuries in the performance of their duties Slattery (1998). The fire service constantly evaluates staffing when it involves the number of firefighters required to effectively and safely mitigate an incident. The International Association of Fire Fighter (2009) reported that companies that operate with a three person crew are more susceptible to injuries than those that used a four person crew. Quite often, money is the determining factor when it comes to the number of firefighters responding on a fire truck. Unfortunately, the fire service continues to have fire trucks respond with two and three person crews.

2.4 The occurrence of injuries and disabilities

Several studies of US firefighters have identified excess health risks, particularly in relation to a range of cancers. A sample of individual studies is summarized in Table 2.1. Baris et al., (2001) conducted a retrospective cohort mortality study of 7,789 Philadelphia firefighters from 1925 to 1986. They calculated standardized mortality rates (SMRs) for firefighters and compared them with mortality rates for white males. They found that firefighters had increased mortality rates for colon cancer and ischemic heart disease. For firefighters with at least 20 years of service, there were elevated risks

of mortality from colon cancer, kidney cancer, non-Hodgkin's lymphoma, multiple myeloma and benign neoplasms.

Bates (2007) studied all male cancers in California during the period 1988-2003 and calculated odds ratios for firefighters for various types of cancer. Firefighters were found to have an elevated risk of testicular cancer (odds ratio of 1.54), melanoma (odds ratio of 1.50), brain cancer (odds ratio of 1.35), esophageal cancer (odds ratio of 1.48) and prostate cancer (odds ratio of 1.22).In a study of Massachusetts firefighters between 1987 and 2003, Kang et al. (2008) used a standardized morbidity odds ratio (SMOR) to examine cancer risk by occupation. The study found that firefighters had a moderately elevated risk for colon cancer (SMOR=1.36) and brain cancer (SMOR=1.9). There was weaker evidence for increased risk for bladder cancer, kidney cancer and Hodgkin's lymphoma.

Coggon et al. (2009) analyzed mortality rates by occupation in England and Wales between 1991 and 2000 using proportional mortality rates (PMR) by occupation. PMRs represent the proportion of observed deaths to expected deaths for the population aged 16 to 74 years after adjusting for age and social group (to reduce the confounding impact of non-occupational factors). Fire service personnel were found to have higher than expected PMRs for: cancer of the pleura (PMR of 223); nonmelanoma skin cancer (PMR of 268); death from falls (PMR of 129 from unspecified falls and 161 for other falls); death from injury by fire (PMR of 274); drowning (PMR of 1970); and firearms (PMR of 567).

A retrospective cohort study by *Bates et al. (2000*) investigated whether firefighters in Wellington had higher than expected risks of mortality or cancer, especially testicular cancer. They matched data from a register of all NZ firefighters who had worked for at least one year as a paid firefighter between 1977 and 1996 with mortality and cancer

records and calculated standardized incidence ratios (SIRs) and standardized mortality ratios (SMRs). They compared the results for firefighters with expected numbers based on the entire population adjusted for age. The analysis revealed that the overall mortality rate for firefighters was below what would be expected. This could be related to the healthy worker effect discussed previously. Similarly, the overall cancer incidence was as expected. However, the higher incidence of testicular cancer was unlikely to be due to chance. For the total period the SIR for testicular cancer was 1.55. For the period 1990 to 1996 the SIR was 2.97 which indicated that firefighters were around three times as likely to have testicular cancer as the general population.

Clearly, the desire and attempt to decrease workplace injuries and illnesses in both the public and private sectors are to be commended; yet workplace injuries and deaths continue to have an adverse impact in the workforce. For example, workman's compensation claims cost organizations millions each year. According to Liberty Mutual Workplace Safety Index (2004, p.1), "serious work related injuries cost the employers approximately $1 billion per week in 2002 in payments to injured workers and their medical care providers, growing to $49.6 billion from 46.1 billion in 2001". In the first three quarters of the fiscal year 2009, CFD incurred a cost of $384,471 in workman compensation claims (City of Charlotte Risk Management, 2009). This is an increase of $80,492 over the total cost of the fiscal year 2008 with a quarter yet to go. Workman compensation is a form of insurance that generally protects the employer from being sued by the employee. However, the employer is responsible for paying the injured employee a percent of his or her base salary.

In addition, many organizations focus on the direct costs and not the indirect costs. Yet, according to Michaud (1995), indirect costs can be more crippling to an organization than direct costs. Direct cost entails the treatment or compensation for the injury or illness sustained in the line of duty. Indirect cost involves all other costs, for

example cost of personal protective Firefighters' Injuries 19 equipment, administrative cost, and cost of safety officers (NIST, 2004). For instance, the death of a firefighter killed in the line-of-duty causes a huge amount of indirect costs; since the morale and performance of the department suffers as co- workers attempt to cope with the loss of a fellow firefighter. According to Smith (2001), it is essential that fire departments have a critical incident debriefing programme in place to handle both lower-profile incidents and large-scale critical incidents.

2.5 Level of preparedness in managing occupational injuries among fire firefighters

Implementation of safety measures is very essential in an injury prone organization like the fire service. These include institution of proper health surveillance systems, organizing regular health safety training for all staff and ensuring that all personnel have access to protective clothing.

Also, equipment advancements in the fire service have had both a positive and a negative effect on firefighters. Lawson (1998) stated that materials used to construct firefighters' bunker gear have improved significantly, which has allowed firefighters to advance deeper into the fire without damage to their protective clothing. However, the fire service has seen significant thermal burns to firefighters due to the inability of their protective clothing to allow the evaporation of moisture trapped inside their protective clothing. Thermal burns are the result of scalding liquids or steam coming in contact with someone's skin *(Limmer and O'Keefe, 2005).*

In addition, firefighters must wear the personal protective equipment (PPE) supplied by the department. Often firefighters become complacent during certain fire operation functions on the fire scene and disregard their PPE. For instance, during overhaul, firefighters will take their SCBAs off because of its discomfort and the lack of smoke. According to *Bolstad, et al., (2000)* during overhaul carbon monoxide often exceeds

the occupational exposure limits of 250 parts per million. Cardiovascular diseases and cancer accounts for a large percent of firefighter's illnesses, and they have a significant impact on the emotional wellbeing of the department. According to the United States Fire Academy (USFA) (2009), heart attacks continue to be the leading cause of line-of-duty deaths for firefighters. In fact, heart attacks accounted for 43 percent of line-of-duty deaths involving firefighters (USFA, 2009). Although firefighting involves strenuous activity, which places a tremendous strain on the heart, 43 percent line-of-duty deaths, due to cardiac arrest, is unacceptable.

Athletes, like firefighters, place a great deal of stress on their heart when training as well as performing in games. Clearly, athletes are considered to be the ultimate figure of health. Yet, according to *Sayre (2007),* cardiac arrest is the leading cause of death in competitive sports. Quite often these are young adults, who exhibited no sign of cardiac problems. Another segment of society considered to be healthy and physically fit is young military recruits. Although cardiac arrest is rare among young military recruits, it accounts for 51% of non-traumatic deaths (Eckart, 2004). This number was staggering because of the comprehensive pre-enlistment health screening programme the military has in place. Due to the atmosphere in which firefighters work, they are more susceptible to debilitating illnesses when compared to other occupations. Additionally, heart conditions and cancer, in many instances, are considered to be a pre-existing condition. According to the International Association of Fire Fighters (2009), forty-two states and seven provinces have some form of presumptive law.

Therefore, firefighters in states without a presumptive law cannot rely on workman's compensation to obtain medical assistance or disability benefits (International Association of Fire Fighters, 2009).

It is a scientific fact that because fire fighters are exposed to toxins at a higher rate than employees in most other professions, there is a higher incidence of many occupational

diseases. Denying fire fighters a safety net in the event they get sick on the job is abandoning those who have sacrificed for their community *(Schaitberger (2009), p. 21)*. In 2005, a group of Arundel County, Maryland firefighters was stricken with cancer following training involving toxic smoke. Over a nine year period (1971- 1979), Arundel County conducted live fire training for its firefighters using polychlorinated biphenyls (PBS) as fuel. Therefore, in 2005 Johns Hopkins

Bloomberg School of Public Health was contracted by Maryland Department of Health and Mental Hygiene to determine if there was a direct link between the toxic smoke inhaled by a group of firefighters during this training period and cancer. The theory is they contracted the cancer during training from the toxic smoke. According to the results of the study, there was no direct link between the toxic smoke generated by the (PBS) and the cancer contracted by the firefighters *(Samet and Bhavsar, 2005).* Regardless of the study, the fire service must continue to fight for the implementation of presumptive laws in all countries.

2.6 Collecting and Improving Injury and Near-Miss Data

A comprehensive literature review was conducted to examine existing research related to and near-miss data collection, analysis, and reporting. The review highlighted current challenges and it should be noted that literature related to many different occupations is incorporated here, primarily because refereed research articles relating to firefighting are extremely limited in both number and topic. General labour and occupational research was used to describe the importance of injury data collection to organizations and professions. However, much of the literature presented in this review is based on injuries, accidents, and experiences in high reliability organizations (HROs). Firefighting teams, fire department administrators, and emergency incident commanders have all been included as subjects in research focusing on HROs *(Compton, 2008; Meyers, 2005; Scott & Tretheway, 2008; Weick, 1993)*. And, there is extensive research on professions that are similar to the fire service (in terms of risk

factors, complex systems, and normal accidents) that are considered to be HROs. Therefore, research based on professions that are similar to firefighting is perhaps the closest substitute. The work examined for this ARP looks at those that are specifically comparable to the fire service: the military, national defense systems (NASA and U.S. Navy nuclear submarines), high-risk industrial organizations (mining and electrical line work), and the commercial airlines.

2.6.1 How can injury reporting improves firefighter safety?

Occupational injury surveillance is a critical component of an organization's risk management efforts. Research has shown that injury reporting can reduce risk and improve worker safety because of changes at both the employee and organizational level. If minor accidents and injuries go unreported, more serious injuries are likely to occur *(Lauver, Lester, & Le, 2009)*. Often, individual members change or adjust their own behaviors when they learn of an accident (Madsen, 2009). Furthermore, reporting even minor accidents and injuries reminds workers of the hazards inherent in their jobs; Madsen (2009, p. 872) showed that participants respond by changing their own mental safety model and by becoming more compliant with existing safety regulations. Firefighters have a tendency to discount the hazards and danger associated with their profession (Scott & Tretheway, 2008) and researchers emphasize that perceived hazards influence a worker's safety values and behaviour *(Clarke, 1998; Earnest, 2000; Pransky, Snyder, Dembe, & Himmelstein, 1999). Earnest (2000)* noted that workers are unlikely to develop basic safety values if they believe the hazards and injury experiences of their job are normal, average, or as expected. Injury reporting paints an accurate picture of accident and injury experiences in the workplace; this impacts worker safety because they adjust their safety values and behaviour based on their perception of occupational hazards. For example, a critical review of NASA's experiences following the shuttle disasters indicated that actors are most likely to learn when they have access to data about past results *(Maher & Casamayou, 2009).*

Injury reporting and analysis can affect worker safety because of changes at the organizational level as well. Employers can track when and where injuries occur so that current safety problems and potential issues can be addressed *(Lauver et al., 2009).* Injury investigations allow agencies to discover the root causes of accidents and system failures *(Welborn & Boraiko, 2009).* These investigations often result in corrective measures. Consider the following example: the U.S. Navy was

experiencing a high percentage of aviation accidents and it found that nearly one-third related to routine violations. Using a specific accident investigation system, the Navy identified the cause and implemented interventions that reduced the percentage of accidents related to the violations, and sustained the reduction over time ("About HFACS," n.d.). Hofmann and Stetzer (1998) found that when administrators foster a positive safety climate, workers are more open to discussing errors and problems. Open communication is necessary so that administrators, and workers, may have a clear understanding of the hazards associated with their work duties. In fact, organizations where employees believe their administration is serious about safety performance, welcomes suggestions about safety and accidents, and is "approachable" have lower occupational injury rates than others that do not score well on safety climate ratings *(Krause et al., 2010).* Relatedly, senior leadership familiarity or knowledge of their company's injury history (like employee names and the details of the injury event) is positively correlated to low occupational injury rates *(Krause et al., 2010).*

2.6.2 How can near-miss reporting impact firefighter safety?

Lauver et al. defined a near-miss as "anytime an employee felt that they were in an unsafe situation due to circumstances, equipment, or their own actions which had a high probability of resulting in an injury, and only by good fortune did the employee remain uninjured" (2009, para. 5). Near-miss definitions vary and may even include incidents that result in damage or injuries but not death. For instance, the largest firefighter near-

miss reporting site lists seven "loss potential" categories that vary by degree of damage: life-threatening injury, lost-time injury, minor injury, property damage, environmental damage, unknown, and other *(National Fire Fighter NearMiss Reporting System website, n.d.).*

Essentially, injury data capture the unfortunate individuals. To illustrate this, Lauver et al. cited Heinrich's (1931) finding that for every 300 unsafe acts, 29 minor injuries occur and one major injury occurs (Lauver et al., 2009, para. 2). Thus, near-misses are often pre-cursors and valuable warning signs of existing safety problems *(Maher & Casamayou, 2009)*. "A near miss by luck is no different to a midair collision from an organizational failure viewpoint and hence the reaction to the two should be identical" *(Rose, 2004, p. 470).* Documenting near-misses can provide a more true picture of workplace hazards *(Krause et al., 2010).* Injury reports alone are often unreliable because of the many barriers that complicate employee reporting *(Azaroff et al.,*

2002). Krause et al. (2010) found that an organization's number of near-miss events was positively correlated with its injury rate.

Learning from experience about how some seemingly minor errors can result in a major failure or severe injury leads to concentrated efforts to find ways to recognize and prevent future accidents *(Maher & Casamayou, 2009, p. 32). Madsen (2009*) compared the effects of prior disaster experience on subsequent organizational safety in the U.S. coal mining industry. Specifically, he examined the impact of direct versus vicarious experience of disasters and minor accidents on mine safety. Although organizational learning depreciates at different rates based on the type and age of experience (vicarious versus direct, recent versus old), organizations can, and do, learn from injury and near-miss events. Research also indicates that a variety of experiences is preferable; it results in a larger set of causal interpretations and a wider search for effective solutions *(Maher & Casamayou, 2009, p. 179).*

At the 2010 Engineering and Operations Conference Line workers Roundtable, those present recommended capturing near-miss data as a way to improve their existing safety programmes. Consequently, the American Public Power Association (APPA) collected a selection of near-miss forms and policies to help members start programmes of their own. The APPA recognized that near-miss reporting can help focus safety training and provide a foundation for worker "tailgate talks" (American Public Power Association, 2010, p. 3). Furthermore, the collection authors noted that using a near-miss form is an excellent way to reinforce the group's safety culture and promote organizational learning.

Some fire service agencies recommend incorporating lessons learned programmes similar to CALL into fire department injury prevention and risk management programmes. The most recent annual report from the Texas State Fire Marshal's office advocates communicating "lessons learned" from firefighter fatality investigations as a strategy for preventing future firefighter fatalities *(State Fire Marshal's Office, 2011, p. 9).* Additionally, the International Association of Fire Chiefs introduced the National Fire Fighter Near-Miss Reporting System in 2005. The goal of this reporting system is to prevent firefighter injuries and deaths by "collecting, sharing, and analyzing near-miss experiences" *(National Fire Fighter Near-Miss Reporting System, 2005, para. 1).* Researchers caution, however, that some severe injuries and fatalities are not always preceded by a series of unsafe behaviours or near-misses *(Krause et al., 2010).* Certain behaviours and events always result in an injury or fatality. For example, unprotected exposure to high-energy events like explosions, radiation, and nuclear reactions consistently results in personal insult, injury, and even death.

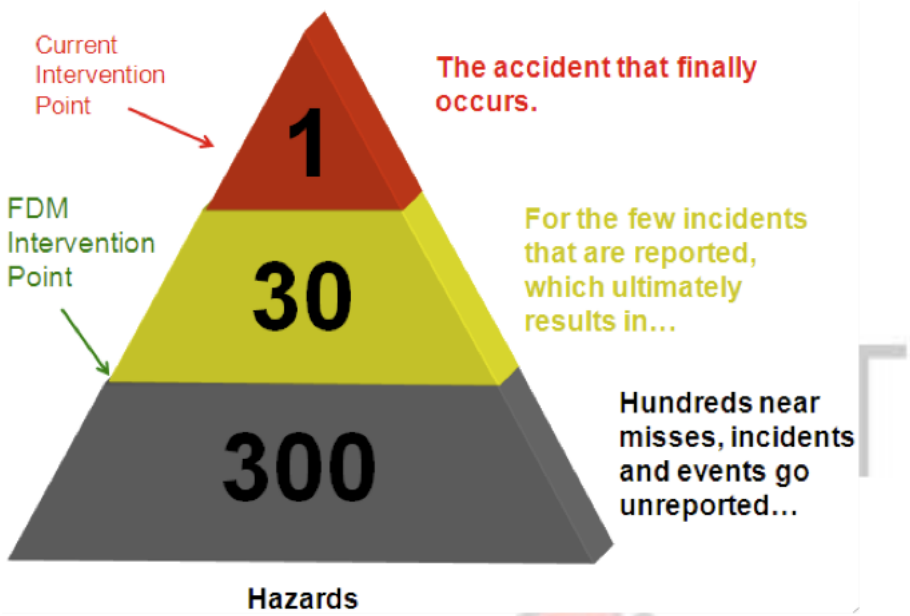


Figure 2.3 Heinrich Pyramid with Intervention Points

2.6.3 How do organizations use injury and near-miss data to make changes that affect firefighter safety?

Current research illustrates the many ways that organizations use injury and near-miss data to make changes that improve worker safety. A safety programme that includes clear accident and incident reporting requirements, incorporates trend analysis, and encourages open discussion that enhance the overall safety of an organization *(Rogers Commission, 1986)*. A strong organizational safety culture is correlated with safer working environments *(Columbia Accident Investigation Board, 2003)*. Reason (1997) noted that a healthy safety culture should focus on reporting and learning, rather than assigning blame. And, the goal of any organization's incident reporting and investigation system should be to support corporate safety measures that come from lessons learned (Rose, 2004). Accurate accident and incident reporting can help organizations decide where to focus resources to make cultural changes for safety *(Krause & Russell, 1994)*. When employees believe their supervisors value safety they are more likely to report occupational injuries and illnesses and participate in investigations *(Lauver et al., 2009)*.

Supervisor support for safety behaviour and a safety culture often results in a positive change in employee attitude towards safety *(Littlejohn, Margaryan, & Lukic, 2010).* Injury and near-miss analyses allow organizations to assemble key information related to employee safety. This is a prerequisite for the process that allows organizational and individual learning to occur; workers must have access to data and acknowledge that results or outcomes are unsatisfactory *(Maher & Casamayou, 2009).* Once employees or managers acknowledge this, change can begin through informal processes like casual communication and adjustments in expectations and norms.

Next, injury and near-miss data is used in the decision-making process by organizations when they make formal policy, equipment, and training changes. Often, data analyses indicate problem areas and identify systems that need improvement *(Columbia Accident Investigation Board, 2003; Krause & Russell, 1994).* Monitoring minor accidents and near-misses allows organizations to adjust safety policies and procedures and possibly prevent future incidents *(Lauver et al., 2009).* Actually, making policy, rule, and standard operating procedure changes based on injury and accident data is recognized as one of the first steps towards organizational learning *(Maher & Casamayou, 2009).* Research has found that organizations with very low frequencies of accidents and injuries have processes in place that allow them to develop new rules and procedures when faced with unexpected or undesirable results. The same research also shows that formal and repeated training efforts based on past experiences lead to low organizational accident and injury rates *(Wong, Desai, Madsen, Roberts, & Ciavarelli, 2005).*

Injury and near-miss reporting can help organizations evaluate the current state of operations and changes in policy, training, and equipment, as well as individual and team performance. Measuring performance can help organizations determine whether safety efforts are having the desired outcome (Petersen, 1998). Certain programmes can

be used to assess an organization's present safety environment and even provide insight to trends through past or historical event analysis ("About HFACS," n.d.). Earnest (2000) emphasized the value of measuring before-the-fact and after-the-fact performances; a system like this provides a means to hold managers or workers accountable for injury and loss experienced after a policy or procedure change. It also gives organizations a way to measure the effectiveness of the change.

Injury and near-miss reporting is an essential part of an organization's risk management plan. In general, the fire service effectively manages public risk, yet most fire departments do not apply the same risk management practices to their own organizations *(Loflin & Kipp, 1997, p. 32).* Past accident and injury statistics help identify high-risk processes or behaviours and the frequency and severity of these events helps managers set priorities for action. After new safety measures and policies are developed and put in place, the final step is monitoring the results. Importantly, the changes that stem from injury and near-miss data analysis should result in better safety and financial security for employees, as well as improved productivity and cost savings for employers *(FIRST, Drexel School of Public Health Website, n.d., p. 5).*

Maintaining accurate data on injury and near-miss events strengthens an organization's risk management programme and proves compliance with certain workplace standards. Employers can use injury and near-miss data analysis as a foundation for learning. Organizational learning is especially difficult for public agencies *(Maher & Casamayou, 2009).* Often, when organizations recognize unsatisfactory results, they strive to produce more favourable outcomes. Frequently, these types of changes carry a financial impact; organizations can use injury and nearmiss data to aid in budgeting and resource allocation. Research suggests that there are many ways to impact firefighter safety. The majority of firefighter injuries occur on the fire ground *(Karter,*

2009; Karter & Molis, 2011; TriData Corporation, 2004). So, many argue that any investment that reduces structure fires can impact overall firefighter safety.

Organizations can use injury and near-miss data to bolster support for changes in staffing and equipment, and to promote investments in training, fire prevention, technology, physical fitness, and recruiting *(Loflin & Kipp, 1997; TriData Corporation, 2004).* Injury and near-miss data can also be used to educate researchers, industry, and the public. Feedback from analyses contributes to equipment modifications by manufacturers and changes in professional standards. Changes in firefighter protective ensembles, self-contained breathing apparatus design and standards of use, closed-cab apparatus, and advanced restraint systems have all been improved as a result of injury information sharing *(TriData Corporation, 2004).*

Occupational health researchers can benefit from organizational injury and near-miss data collection. For example, NORA aims to develop a system to collect firefighter injury information in a central repository by 2012 and NIOSH recognizes that all federal agencies can benefit from increasing coordination and information exchange *("Surveillance Strategic Plan," n.d.; NIOSH, 2011). Madsen (2009)* found that fatal accident experiences in mines had a significant and measurable impact on worker safety because they prompted changes in government mine safety laws and regulations. Public officials and stakeholders can be persuaded to modify their expectations, change municipal requirements, and support budget items when they are educated about the nature of an organization's safety or health problem, possible solutions, and resources needed *(Levy, 1996).* Alternatively, if statistics are not available to describe a safety problem and its consequences, stakeholders and officials are likely to invest in solving other, more immediate problems *(Maher & Casamayou, 2009).*

2.6.4 What factors influence the success of an injury or near-miss reporting programme?

A method to communicate results and share information with others is a critical component of an injury and near-miss reporting system. Failure or weakness in this area has been cited as a causal factor in numerous accident and fatality investigation *(Rogers Commission, 1986; Columbia Accident Investigation Board, 2003).* In the aftermath of some well-publicized system failures, NASA spent the years between the Challenger and Columbia shuttle accidents working on a unified reporting center, to make it easier to spot problems and trends as well as disseminate lessons learned across the organization *(Maher & Casamayou, 2009).* The system must be accessible, or "user-friendly," as well. NASA's problems with this are well documented; key information about previous failures and near-misses was not getting to the right players. Furthermore, reporting systems should be empowering for all. There were instances where workers suspected a hazard or problem but stayed silent because they did not have access to data that could provide objective support or justify their feelings *(Maher & Casamayou, 2009, p. 175).* And, in some cases, low-level workers who knew of problems did not have enough clearance to submit a report; thus, serious information was not recorded or communicated to decision-makers.

An organization's intent, or motivation, for requiring injury and near-miss reporting influences worker participation. Workers that fear punishment, retribution, or criticism are likely to remain silent *(Maher & Casamayou, 2009; Rose, 2004).* Fortunately, research suggests that there are ways to encourage employee participation. A shift towards an organizational culture that allows workers to feel like reporting is an opportunity rather than a self-sacrificing event can increase reporting and organizational safety *(Hofmann & Stetzer, 1998; Morris & Moore, 2000).* The outstanding success of the U.S. Army's CALL Center is an example of this type of change (United States Army, n.d.).

Two additional ways to effect positive change toward injury and near-miss reporting is to ensure anonymity or re-direct accountability to an outside agency. One model, the Aviation Safety Reporting System (ASRS), ensures confidentiality to reporters, waives fines and penalties in approved cases, and uses the information to promote aviation safety in a variety of ways (ASRS - Aviation Safety Reporting System website, n.d.). Similarly, the system used by the American Medical Association is non-punitive, and guarantees confidentiality and protection in legal proceedings for those who report accidents and failures (Morris & Moore, 2000). Finally, the Fire Fighter Near-Miss Reporting System also emphasizes that its programme is confidential, non-punitive, voluntary, and secure *(National Fire Fighter Near-Miss Reporting System website, n.d., para.* 1).

There is ample evidence that accountability influences the frequency and accuracy of employee injury and near-miss reports. Performance and organizational pressure to achieve cause workers conflict when they are faced with choices about reporting *(Lebovic, 1995).* Likewise, the personal desire to avoid discipline and embarrassment shapes worker decisions about reporting *(Lerner &Tetlock, 1999; Rose, 2004).* In fact, increasing levels of accountability and the potential for punishment are associated with less individual learning and fewer reports *(Morris & Moore, 2000). Mahler and Casamayou (2009)* pointed out that this is especially troubling for public organizations, because accountability is vital and expected in civic departments.

Certain logistical aspects of injury and near-miss reporting systems seem to impact their success. Research indicates that investigations should examine system and organizational processes that may be the root causes for individual accidents or failures (Columbia Accident Investigation Board, 2003; Petersen, 1998). It has been argued that incident analyses should examine all actors that directly or indirectly influence the work situations or processes involved in the accident *(Kunadharaju, Smith, & DeJoy, 2011;*

Sklet, 2004). In their detailed examination of NIOSH firefighter LODD investigations, *Kunadharaju et al. (2011)* found that the contributing factors for the deaths could all be traced back to four core causes at the system and/or organizational level: under-resourcing, inadequate preparation for/anticipation of adverse events, incomplete adoption of incident command procedures, and sub-optimal personnel readiness.

Several factors impact a reporting system's value or worth. Surveillance systems are investments, and organizations must monitor their cost and benefits. Petersen (1998) advised that a safety programme should reveal the financial impact of employee injuries and near-misses (see also TriData Corporation, 2004). Likewise, the FIRST Programme added a financial variable o its descriptions of firefighter non-fatal injuries *(Taylor & Roman, 2011).* Report forms should also conform to an organization's legal and insurance requirements, and professional standards when possible *(Petersen, 1998).*

Lastly, researchers have made recommendations about the types of data that organizations should collect. Recall that NIOSH's NORA programme is focusing specifically on reducing fire ground injuries. Recent reports indicate that collecting information about fire ground injuries may have the largest influence on firefighter safety, because the majority of injuries occur here ("Fire-related firefighter injuries," 2011). Currently, researchers are promoting the use of a standardized set of occupational injury codes *(Taylor, 2011; Taylor & Roman, 2011).* Evidence suggests that entire professions and industries could benefit from such a system; organizations can contribute to the benefit of a larger group if they incorporate standardized codes into their reporting systems ("Surveillance Strategic Plan," n.d.).

In summary, the research reviewed here stress the need for injury and near-miss reporting in all professions. The existing research is primarily qualitative and descriptive; the majority of the data reported was derived from interviews, focus groups, and participant observers. Therefore, these types of research methods were the

foundation for the type of original research applied to this project. Finally, the literature reviewed here supported the research purpose and highlighted the relevance of the research questions presented in this project. Based on the literature reviewed here, one can understand the individual, organizational, and professional benefits and challenges that are associated with reporting programmes. Occupational health researchers note the importance of reporting in a profession like the fire service because it is a high hazard occupation suffering a steady rate of fatalities and injuries every year. Yet, peer-reviewed research articles based specifically on injury and nearmiss Reporting in the fire service are largely absent from the current occupational health dialogue. The currents study aimed to address this gap in the existing occupational health literature by examining how injury and near-miss data collection is being used in the fire service, especially in Ghana.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

The purpose of this study was to explore and, consequently, assess the triggers and types of injury and disabilities and their implications on operational fire-fighters in Ghana; with the view to develop or enhance risk management programmes within the Ghana National Fire Service (GNFS). This chapter discusses how the research was carried out. Included in this chapter are the following sections: study design, variables, population and sample, data collection instruments, data collection procedures, and data analysis.

3.1 Study Design

This study used a cross sectional design, which examined the relationships between key selected organizational systems, and injury prevention guideline and policy statements.

Injury data analyzed in the study were compiled from three geographical diverse municipal, metropolitan and district fire stations (MMDFS) in the Greater Accra, Central and Western Regions, in Ghana. Data were limited to fire-fighter lineof-duty (LOD) injuries occurring during the year of 2009 - 2013 with sufficient information for analysis.

3.2 Study Site

Each of the fire stations protects an estimated average of 200 square kilometers within the incorporated city limits. All the fire stations in the regions, services airports, commercial ports or habours, cruise ship terminals, flammable liquids storage facilities, hazardous materials storage facilities, high rise sky scrapers, and all other types of commercial and residential occupancies associated with urban areas.

3.3 Study Population

The population of this study consisted of fire fighters from large urban fire stations. Participants for this study were randomly drawn from a list of operational fire fighters, training officers and staff of paramedic unit, who are assigned to either the fire suppression and rescue services; with the exception of municipal metropolitan and district fire officers (MDFOS') and personal from other departments or directorates or units who are neither operational fire fighters, training officers or paramedic staff or are not directly assigned to fire suppression and rescuing.

3.4 Sampling and Sample Size

Respondents in this study were selected randomly. In the selected fire stations, respondents were sampled using the lottery method where pieces of papers with inscriptions “YES” and “NO” were written for picking. Respondents who picked ‘YES” and consented to participate in the study were enrolled. These processes were repeated in all the selected stations till the required sample size was achieved.

The sample size included 230 participants who were randomly selected from a list of 522 operational fire fighters, training officers and paramedic staff working directly under the Ghana National Fire Service (GNFS), in three selected regions of Ghana. The sample size was estimated using as assumed prevalence rate of 20%. As per the formula of Kirkwood and Sterne, 2003, the sample was estimated by using the formula,

$$n = \frac{Z^2 pq}{d^2}$$

Where n = the desired sample size z = the standard normal deviation 1.96 p = the proportion in the target population estimated to be 20% (0.20) q = 1.0-p d = degree of accuracy desired at 0 .05.

$$n = \frac{(1.96)^2 \times (0.20) \times (0.80)}{(0.05)^2}$$

n = 245

Table: 3.1 Summary of sample distribution

Name of Fire Stations & Regions	Total population	Proportion of population sampled	Total sample
Greater – Accra Regional Fire Command	146	146/522=0.28	69
Central Regional Fire Command	120	120/522=0.23	56
Western Regional Fire Command	110	110/522=0.21	51
Ashanti Regional Fire Command	146	146/522=0.28	69
Total	**522**		**245**

Source: Field survey, 2015

Among the selected participants, 203 (88.3%) were operational firefighters; 9 (3.1%) training officers; 12 (5.2%) crew leaders and 6 (2.6%) were paramedic staff.

3.5 Study Variables

The independent variables for the study included adequate injury and near- miss reporting programmes, effective and efficient training methodologies, adequate and standardized use of personal protective equipment, adequate medical care for personnel, frequency and response rate to fire outbreaks, standard operating procedures, conducive work environment, and fire fighter characteristics of age, education, length of service and type of injury. The main dependent variable was occupational injury and related disabilities. Other sub-dependent variables included the demonstration of knowledge in injuries and disabilities, competencies in the operation and use of life saving and emergency equipment, as well as their maintenance regimes, the extensive job schedule or the shift work of fire fighters, reduction in the number of potential casualties, the standard work regulation of 24/7 duty post and a formidable and cohesive teamwork and group dynamic of staff members.

3.6 Data Collection Tools

Self-administered questionnaires were used to collect data from the operational fire fighters, municipal and training officers, and the paramedic staff. Using the questionnaire as a guide, unstructured interviews were also conducted for the key informant's interviews. The procedure involved the fire fighters, training officers, and the paramedic staff who were met on separate sessions with each group on two simultaneous occasions. Therefore, the focus group discussions with not less than eight (8) officers were also held to augment the initial questionnaire administration and the interviewing. Respective moderators and recorders were employed during these sessions to direct and write or record sectionals notes. The use of requisite stationary, including tape-recorders and digital-cameras were made available for use as tools on the field.

Consequently, the direct observation technique with the aid of checklists were applied in some instances, since the process involved the inspection of live-saving equipment, i.e. Personal Protective Equipment (PPES'), the availability of emergency medication and the medical equipment of the paramedic unit, as well as, fire stations using a checklist.

Data compiled included cases information for each line-of-duty injury as well as known contributing factors and triggers to the injury including one or more of the following: officer/incident command response, crew size, personal protective. Equipment failure, lack of training, lack of communication, standard operating guidelines/procedures, structural failure, lack of situational awareness, human error, or lack of teamwork. Data for each LOD injury and associated triggers were compiled from reports profiling the incident leading to the injury as communicated by the victim, peers, and officers and as recorded by each respective fire station's injury tracking mechanism. Methods for data collection, recording and reporting varied between stations. Though similar none of the fire stations' collected or reported fire fighter injury the same way. Therefore, data compilation was conducted on a case-bycase basis to assure proper transfer of information and an accurate transfer of data element definition to the master database used for analysis. A total of 318 cases had sufficient information available for inclusion in the study.

3.7 Data Analysis

Descriptive data for each LOD injury and associated contributing factors were compiled from reports profiling the incident leading to the injury as communicated by the victim, peers, and officers and as recorded by each respective fire stations injury tracking mechanism. Data were submitted and compiled into a master database for analysis. Data tables were prepared with all study relevant information.

Data were analyzed to assess the frequency of identified contributing factors and the circumstances in which the injury occurred. As injury relevant circumstances and contributing factors were communicated; a variable key was constructed containing each variable name and the definition as referenced in data source reports. Frequency analysis was used to organize the data into meaningful structures, or to develop taxonomies or groups of contributing factors that occur together. The aim of cluster analysis was to sort different factors into groups in a way that the degree of association between two factors is maximal if they belong to the same group and minimal otherwise. Clustering is typically used to discover structures in data without providing an explanation or interpretation as why they exist. Clusters provide a springboard for future research to better identify why relationships exist between various factors.

The study was based on data extracted from eighteen municipal, metropolitan and district fire stations' occurrence books, sub-conduct registers and the 24hr investigative reports for the years 2009-2013. These data were cross-referenced with data elements and definitions used in the near-miss reporting system to assure industry consistency in use of terms reorganized in the fire service industry. The term

"on-duty" refers to a firefighter being involved in operations at the scene of an emergency, whether it is a fire or non-fire incident, responding to or returning from an incident, or performing other officially assigned duties such as training, maintenance, rescuing public education, inspection, and investigations.

The data analysis used to answer the research questions utilized both descriptive and correlation statistics in order to identify significant factors related to fire fighter lineof duty injuries. Descriptive statistics were used to compute frequencies, percentages, means and standard deviations. The descriptive statistics were used to describe the characteristics of each variable and the relationship between each independent variable with the dependent variables. The statistical programme used for the study was the

statistical package for social sciences (SPSS) programme. Tables are used to identify the frequencies, percentages, means and standard deviations for the variables as well for the samples rank structure and shift assignment.

A chi-square or Fischer's Exact test was used to test for association between the independent variables injury and near-miss reporting programmes, training programmes; the standard use of personal protective equipment; adequacy of medical care for personnel; response rate to fire outbreaks; standard operating procedures; conducive work environment; and fire fighter characteristics of age education, length of service and type of injury as against the dependent variables knowledge and ability skills, injuries and disabilities skills, the use of personal protective equipment and maintenance, the extensive job schedule or shift or work of fire fighters, reduction in the number of potential casualties, the standard work regulation of 24/7 duty post, and the need for teamwork and group dynamics. Multivariable logistic regression analysis was done to adjust for the confounding effects of the independent variables and to estimate the odds of experiencing injury among fire personnel.

3.8 Ethical considerations

All participants selected were given a letter outlining the conditions of participation, (see Appendix C for a copy of the letter) which was signed by both the researcher and the regional fire officers (RFOS') of the various fire stations. After the participant verbally agreed to participate, a consent form approved by the Committee on Human Research Publication and Ethics of the School of Medical Science, Kwame Nkrumah University of Science and Technology - Kumasi (see Appendix D for a copy of the consent form required by the Human Ethics Committee) explaining the study, a consent form from the fire service used in this study were given to the participant to read and sign in order to document that informed consent was obtained. The fire service's consent form allowed the researcher the authority to review and collect data from each

participant's personal records, regarding the causes, types and effects of occupational related injuries and disabilities from 2009 through 2013.

3.9 Limitations

Factors affecting the external validity of the study are largely attributed to various demographics, which offer result in different hazardous conditions experienced by the operational firefighters. The present study, because of where they are being conducted, would exclude certain factors associated with fire fighter line-of-duty injuries. Many injuries reported in the various regions include slip and fall resulting from water used for fire suppression. This Hazard has never been a factor related to injuries for the participants used in study.

Another limitation affecting the external validity is the difference between urban and rural fire fighting conditions. Wildland or bush fires due to their unpredictable nature are responsible for firefighting injuries every year most wildland fires occur in rural areas. The absence of both of these situations, water releases and wildland fires, are factors which threaten the ecological validity of the study. The threats to internal validity include the fact that the independent variable were not manipulated, and are naturally occurring.

A major strength of the study with respect to the characteristics of the participants and the various settings where injuries occur includes the procedure of dispatch, which results in participants being somewhat randomly assigned to the various types of episodes where injuries most frequently occur. Any member of the sample can be summoned at any time during their 24-hour shift to five of the seven types of episodes used in the study (commercial structure fire, residential structure fire, vehicle fire, emergency medical care incident, or traffic accidents that occur while responding to or returning from an activities and training activities) are evenly distributed among the sample ass a constantly reoccurring episode.

CHAPTER FOUR

RESULTS

4.0 Introduction

This chapter presents results of the study. The results are presented in tables and figures preceded by a narration.

4.1 Background characteristics of respondents

Table 4.1 presents the background characteristics of respondents in this study. As shown in Table 4.1, most of the respondents (88.3%) of the respondents were occupational fire fighters whereas 3.9% were training officers. Majority, 62.6% had been in the service for more than ten years whereas 23.1% had been serving for 5 to 10years. The mean length of service was 13.8years, SD=7.5. More than half of the respondents were about 35years whereas 8.3% were 25years or younger. 31.3% and 29.1% were 26 to 35years and 36to 45years respectively. With respect to their level of education, 47.8% had secondary school education whereas 20.4% and 20% had tertiary and JSS education respectively. More than 90% of them worked at the operational directorate and majority had been there for more than 10years. The other departments mentioned by respondents included fire safety and training. About 59% had enrolled in NHIS.

Table 4.1: Background characteristics of respondents

Variables	Frequency	Percentage
Role in service		
Occupational fire fighter	203	88.3
Training officer	9	3.9
Watch/crew leader	12	5.2
Paramedic	- 6	- 2.6
Other		

Length of service		
<5years	33	14.3
5-10 years	53	23.1
>10years	144	62.6
Mean (SD)	*13.8 (7.5)*	
Age		
25 year or younger	19	8.3
26 – 35 years	72	31.3
36 – 45 years	67	29.1
46 – 55 years	72	31.3
Level of education		
Junior Secondary School	46	20.0
NVTI Qualification	24 110	10.4
Secondary School		47.8
University/Post-Secondary Degree	47	
Other	3	20.4
		1.3
Department		
Operational directorate	215	93.5
Other department	15	6.5
Length of stay at the department		
Up to 5years	38	16.5
5-10years	67	29.1
>10years	125	54.4
Mean (SD)	*10.8 (6.9)*	
Enrolled in NHIS:		
Yes	136	59.1
No	63	40.9

Source: Field data, 2014

4.2 Fighter injury and disability trends

Table 4.2 presents results of firefighter's perceptions regarding injury and disability trends. About 83% agreed that firefighting and related emergency service delivery begins with its preparedness whereas more than 90% agreed that emergency preparedness and injury prevention is a strategic planning and decision making process. About 55.2% also strongly agreed that prevention of injuries and disability avoidance requires resources mobilization and allocation whereas 28.3% also agreed. About 91%

also conceded that the major components of injury prevention and disabilities include; adequate and well trained fire fighters, standard personal protective equipment, efficient injury and near-miss reports, and common standard operating procedures whereas about 4% disagreed.

Table 4.2 Results of fire fighters perceptions on injury and disability trends

Variables	Frequency	Percentage
Fire fighting and related emergency service delivery begins with its preparedness		
Strongly agree	191	83.0
Agree	18	7.8 2.6
Undecided	6	3.9
Disagree	9	2.6
Strongly disagree	6	
Emergency preparedness and injury prevention is a strategic planning and decision making process		
Strongly agree	143 75	
Agree	3	62.2
Undecided	3	32.6
Disagree	6	1.3 1.3
Strongly disagree		2.6
Prevention of injuries and disability avoidance requires resources mobilization and allocation		
Strongly agree	127	
Agree	65	55.2
Undecided	20	28.3
Disagree	15	8.7 6.5
Strongly disagree	3	1.3
The major components of injury prevention and disabilities include; adequate and well trained fire fighters, standard personal protective equipment, efficient injury and near-miss reports, and common standard operating procedures		
Strongly agree	149	64.8
Agree	60	26.1
Undecided	12	5.2 1.3
Disagree	3	2.6
Strongly disagree	6	

Source: Field data, 2014

4.3 Common triggers and types of injuries and disabilities experienced by fire fighters

Table 4.3 presents' results on types of injuries and disabilities experienced by fire fighters as well as what commonly trigger these injuries. As shown, about 10.4% stated they had experienced major injury whereas 44.4% had also experienced minor injuries. About 48% if these injuries occur at the fire scene whereas 25.6% occur on the way to the scene. Training and simulation exercises also triggered injuries among fire fighters with 23.9% of the respondents citing this as detailed in Table 4.3. The

About 20% stated that some of their colleagues had become permanently disabled and 12% said knew of more than three whereas 36% know of one.

Table 4.3 Types of injuries and disabilities experienced by fire fighters

Variables	Frequency	Percentage
Ever experienced major injury		
Yes	24	10.4
No	206	89.6
Ever experienced minor injury		
Yes	102	44.3
No	128	55.7
Where were you injured (n=117)		
At fire scene	56	47.9
On the way to the fire scene	30	25.6
During training or a simulation exercise	28 3	23.9
When returning from fire fighting		2.6
Any of your colleagues become permanently disabled		
Yes	46	20.0
No	164	71.3
Don't know	20	8.7
Number recalled (n=50)		
One	18	36.0
Two	6	12.0
Three	5	10.0
>3	6	12.0
Cant recall	21	42.0

Source: Field data, 2014

4.4 The occurrence of injuries and disabilities

Table 4.4 shows the experience and responses to injury among the respondents. One hundred and seventeen respondents, constituting 50.8% admitted to ever gotten injured. Majority of the respondents disclosed they treated injury through other means whereas 18.3% and 14.8% treated at the general hospital and clinic respectively. Only 3.9% received treatment to their injuries at the GNFS paramedic unit. About 34.3% paid for the cost of injuries themselves whereas 57% paid through other means other than the fire service (8.7%). Majority could not give precise estimate of how much they spent on treating injury. About 14.2% spent between 100 and GHS 300.00 on injury whereas 6.9% spent less than GHS100.00. However, 97.2% stated that there were no compensation from the service for the injury and cost involved.

Table 4.4 Experience and response to injury

Variables	Frequency	Percentage
Ever gotten injured		
Yes	117	50.8
No	113	49.2
How did you treat injury		
At a General Hospital	42	18.3
A Clinic	34	14.8
Herbal Home	17	7.4
GNFS Paramedic Unit	9	3.9
Other	128	57.6
Who paid for cost of injury		
Fire service	20	8.7
Self	79	34.3
Other	131	57.0
How much paid (from day of injury till discharge) (n=218)		
<100	15	6.9
100-300	31	14.2
>300	6	2.7
Don't know	166	76.1

Any form of compensation? (n=107)		
Yes	3	2.8
No	104	97.2

Source: Field data, 2014

4.5 Training and preparedness towards injury

Table 4.5 also presents results of training and preparedness in the form of standards and policies in the GNFS. Majority 53% stated that they had never had any form of health and safety training. Among those who had training (47%), 24.4% had it annually, 10.8 quarterly and 36.2% weekly. Most of the respondents (78.3%) disclosed that their stations and had no form of health surveillance policy whereas 16.5% indicated that there existed a surveillance policy. About 25.2% stated that personal protective clothing were usually adequate and efficient whereas majority

65.2% believed otherwise. As shown, the level of training received by the fire fighters included health and safety indication course (15.2%), periodic simulation exercises (28.3%), and other forms of training (15.2%). An example of the other forms of training giving by respondents was investigation course. However, 12.2% of the respondents disclosed that they had received no training.

On the presence of standard operating procedures, majority 63% believed there existed whereas 27.4% believed otherwise. Only 6.1% agreed that there existed injury-tracking programmes at the fire station whereas 79.6% stated there was none of such. Majority of the respondents, 65.2% were in agreement that increased efficiency and communication about the circumstance and causes of injuries and near misses would affect your safety as an individual fire fighter. Reasons cited by some of the respondents included personnel becoming aware of the causes and circumstances that lead to injuries, educating personnel on safety and injury matters and alerting them to know the job professionally. Some respondents explained;

"Continues education on the said matter will enable us to be conscious of the fact that are taken care about the safety issues"

"Fire fighting is a team work and as such communication will protect and prevent who ever is working as fire fighter"

Most of the respondents, 53.0% were concerned that lack of injury-related communication within the GNFS may negatively impact fire fighter safety. Some respondents explained that communication is important in teamwork and lack of communication might cause more injuries. Others also indicated that training on injury-related communication would improve their skills on the job.

Table 4.5 Training and level of preparedness

Variables	Frequency	Percentage
Had any form of health and safety training?		
Yes	108	47.0
No	122	53.0
Frequency of training (n=185)		
Annually	47	25.4 10.8
Quarterly	20	21.6
Monthly	40	36.2
Weekly	67	5.9
Daily	11	
Level of training received in current unit		
Health and Safety Induction course	35	15.2 29.1
Regular in-service and refresher courses	67	28.3 12.2
Periodic Simulation exercises	65	15.2
No training	28	
Other (specify)	35	
Station have any form of health surveillance policy		
Yes	38	16.5
No	180	78.3
Don't know	12	5.2

Usual personal protective equipment adequate and efficient		
Yes	58	25.2
No	150	65.2
Don't know	22	9.6
Fire station have any form of standard operating procedures		
Yes	145	63.0
No	63	27.4
Don't know	22	9.6
Fire station have any injury tracking programs		
Yes	14	6.1
No	183	79.6
Don't know	33	14.3

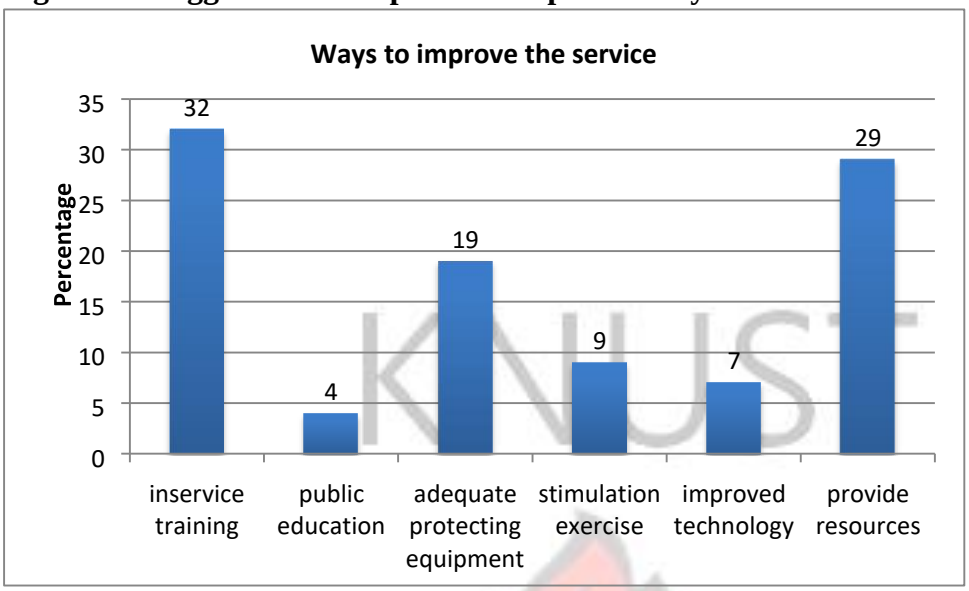
Source: Field data, 2014

As shown in Figure 4.1, 32% of the respondents believed providing in-service training will improve workplace safety whereas 29% stated that more resources should be provided. Other suggestions included providing adequate protecting equipment (19%) and improving technology (7%). On general suggestions to improve the service, some respondents stated there should be encouragement in hazard education, supply of individual protective equipment and provision of place to keep equipment. Other suggestions included providing insurance policy and improving welfare of staffs.

One respondent noted;

"Something should be done to the poor organizational structure which has nothing to pay to compensate or refund any health cases and manage injuries"

Figure 4.1 Suggestions to improve workplace safety



Source: Field data, 2014

Table 4.6 presents results of equipment owned by respondents for personal use and their conditions. As shown, majority of the respondents did not owe most of the equipment. About 79.8%, 84.2%, 70.9% and 74.9% did not owe thermal protective coat, thermal protective pants, helmet and hoods respectively, as detailed in Table 4.4.

About 64% did not have eye protection equipment while 53.8% also did not have work boots. The result however shows that majority of the equipment were in good or adequate condition as presented by the respondents.

Table 4.5 Presence and condition of equipment used by firefighters

Equipment	Have this equipment for your own use		ondition of quipment		
	Yes N (%)	No N (%)	Good	Adequate	Poor
Thermal protective coat (n=218)	44 (20.2)	174 (79.8)	12	12	20
Thermal protective pants (n=203)	32 (15.8)	171 (84.2)	12	14	6
Work boots (n=223)	103 (46.2)	120 (53.8)	33	42	28
Gloves (n=218)	104 (47.7)	114 (52.3)	26	60	18

Helmet (n=213)	62 (29.1)	153 (70.9)	32	15	15
Hood (n=195)	49 (25.1)	146 (74.9)	25	15	9
Eye protection (218)	79 (36.2)	139 (63.8)	44	25	10

Source: Field data, 2014

4.6 Factors influencing injury

This section presents results of the predictors of injury among fire fighters at the GNFS.

4.6.1 Influence of socio-demographic factors on injury among fire fighters As shown in Table 4.6, workplace injury among firefighters was influenced by length of service and level of education. The mean length of service was higher among those who experienced injury as compared to those who had never experienced injury. Experience of injury was also influenced by the level of education with the percentage of staff who experienced injury being significantly higher among those who had NVTI qualification and lower among those with university or post-secondary degree (p<0.001).

Table 4.6 Socio-demographic factors influencing injury

	Ever experienced injury		
Variables	**Yes**	**No**	**p-value**
Length of service, mean (SD)	14.0 (8.1)	13.6 (7.0)	0.000*
Age, %			
25 year or younger	57.9 38.9	42.1 61.1	
26 – 35 years	52.2	47.8	0.204
36 – 45 years	54.2	45.8	
46 – 55 years			
Level of education, %			
Junior Secondary School	62.5 75.0	37.5 25.0	<0.001
NVTI Qualification	44.5	55.5	
Secondary School	19.1	80.9	
University/Post-Secondary Degree			

Test: Chi-square **one way ANOVA*

4.6.2 Influence of level of preparedness on injury among fire fighters

As shown in Table 4.7, having a form of training, presence of surveillance policy and personal protective clothing had significant influence on injury among firefighters. Respondents who had a form of training were less likely to have injury as compared to those who did not have any form of training on health and safety (34.3% versus 76.5%; p<0.001). Again, respondents who believed that usual personal protective equipment were adequate and efficient were also less likely to experience injury at the workplace (29.3% versus 55.8%; p=0.001).

Table 4.7 Level of preparedness and injury among firefighters

Variables	Experienced injury		p-value
	Yes	No	
Had any form of health and safety training?			
Yes	34.3	65.7	<0.001
No	76.5	23.5	
Station have any form of health surveillance policy		76.3	<0.001
Yes	23.7	42.2	
No	57.8		
Usual personal protective equipment adequate and efficient		70.7	
Yes	29.3	44.2	0.001
No	55.8		
Fire station have any form of standard operating procedures		52.4	
Yes	47.6	48.2	0.541
No	51.8		
Fire station have any injury tracking programs			
Yes	57.1	42.9	0.536
No	48.6	51.4	

Test: Chi-square

4.6.3 Owning protective clothing and injury among fire fighters

Table 4.8 also presents results of the influence of owning protective equipment on the experience of injury among firefighters. As shown in the table, ownership of all the equipment studied, with the exception of work boots significantly influenced experience of injury among firefighters. Experience of injuries was significantly lower among respondents who owed thermal protective coat, thermal protective pants, gloves, helmet, hood, eye protection.

Table 4.8 Owning protective equipment and injury among firefighters

Variables	Experienced injury		p-value
	Yes	No	
Thermal protective coat			
Yes	31.8	68.2	0.003
No	56.9	43.1	
Thermal protective pants			
Yes	25.0	75.0	0.001
No	57.9	42.1	
Work boots			
Yes	51.0	49.0	0.892
No	52.5	47.5	
Gloves			
Yes	40.4	59.6	0.001
No	62.3	37.7	
Helmet			
Yes	37.1	62.9	0.009
No	56.9	43.1	
Hood			
Yes	30.8	69.2	<0.001
No	63.0	37.0	
Eye protection			
Yes	40.5	49.5	0.012
No	58.3	41.7	
Number of protective clothing			
None	54.9	45.1	
One/two	46.3	53.7	0.278
Three or more	43.2	56.8	

Test: Chi-square

4.6.4 Logistic regression analysis

Table 4.9 presents results of the univariable and multivariable logistic regression analysis of the influence of socio-demographic variables and level of preparedness in terms of training and policy on occurrence of injuries among fire fighters. Among the socio-demographic variables, the odds of experiencing an injury was higher among respondents with Junior or Secondary education as compared to those with tertiary education although this was not significant in both univariable and multivariable analysis.

In the univariable analysis, absence of any form of health and safety training, absence of surveillance policy and inadequate protective equipment at the fire station increased the occurrence of injuries among fire fighters. When the socio-demographic variables were adjusted for, health and safety training still had significant influence on the experience of injury among fire fighters. Fire fighters from stations with no form of health and safety training were 2.8 times more likely to experience injuries as compared to those from stations with health and safety training, when other variables controlled for (AOR=2.8; 95% CI=1.5-4.8).

Table 4.9 Results of univariable and multivariable regression analysis of factors influencing experience of injuries

Covariates	**Univariable**	**Multivariable**	
	OR (95% CI)	**AOR (95% CI)**	**AOR (95% CI)**
I. Socio-demographic variables Age	0.99 [0.96, 1.03]	0.99 [0.95, 1.03]	0.99 [0.95, 1.03]
Education (ref=Tertiary)			
Junior/senior secondary	1.54 [0.86, 2.76]	1.43 [0.80, 2.57]	1.77 [0.94, 3.35]
II. Preparedness and use of protective clothing			
Health and safety training (ref=yes)			
No	3.17 [1.85, 5.44]***		2.82 [1.4, 5.8]**
Station has surveillance policy (ref=yes)			
No	3.81 [1.71, 8.47]**		1.11 [0.32, 3.0]

Personal protective equipment adequate and efficient (ref=yes)		
	3.05 [1.61, 5.78]**	1.52 [0.51, 4.51]
□ No		
Owes a protective clothing (ref=none)		
	0.72 [0.59, 2.56] □	0.81 [0.43, 1.53]
One or more		

***P<0.01; ***P<0.001 OR=Odds ration AOR=Adjusted odds ratio*

CHAPTER FIVE

DISCUSSION

5.0 Introduction

This chapter discusses the important findings of this study in relation to available literature. The sections are organized according to the objectives of the study.

Firefighting and Emergency Medical Services (EMS) works are fraught with injury and illness. According to a pioneering study by *Maguire et al (2005),* using Department of Labor –occupational injury rates were higher in EMS workers than for workers in any other industry in the United States records. Other studies have also found occupational fatality rate for EMS workers as more than twice the national average *(Maguire, Levick, Hunting, & Smith, 2002).* This therefore calls for a high level of preparedness in terms of policies and guidelines to help curtail injuries among firefighters. NFPA 1500 Standard on Fire Department Occupational and Health Programme (2007) is the standard at which all fire departments compare with and measure their own organization as regards to safe operations.

In low and middle-income countries (LMIC) including Ghana, there is inadequate reporting on the incidence and fatality of injuries relating to occupation. However, are increasingly recognized as a growing health problem in LMICs. They have been shown to be a leading cause of death among younger working-aged adults *(Loewenson, 1999;*

Leigh et al, 1999) and the leading cause of disability and of health-related economic losses *(Krug, 1999; Mock et al, 2004).*

5.1 Background Characteristics

This study sought to assess injuries among firefighters in Ghana and the level of preparedness to deal with injuries. Most of the respondents were occupational fire fighters, and had been in the service for more than ten years whereas. This indicates that there are more experienced staffs and this could have a positive influence of injury management at the fire stations. However, this will much depend on the availability of the requisite safety tools and policies at the various fire stations. More than 90% of the respondents worked at the operational directorate and majority had been there for more than 10years.

5.2 Fire injury and Disability Trends

Injuries contribute greatly to years lost due to disability (YLD) especially in lowincome countries and fire fighters are among the occupations at high risk of injuries. In this study, most of the firefighters agreed to the fact that preparedness is very essential in emergency service delivery. About 83% also agreed that fire fighting and related emergency service delivery begin with its preparedness whereas more than 90% agreed that emergency preparedness and injury prevention are strategic planning and decision making process. This is a good indication, as most of the firefighters knew the essence of adequate preparedness in the service.

Resourcing staff adequately is essential to injury prevention and disability avoidance in the service. In this study, most of the firefighters also agreed to this and about 91% also conceded that the major components of injury prevention and disabilities include; adequate and well trained fire fighters, standard personal protective equipment, efficient injury and near-miss reports, and common standard operating procedures. Training is also an important aspect of preparedness. In emergency services, staff need

to be trained regularly on injury prevention and disability management. Training is also needed to constantly update staff's knowledge on new equipment and technologies as well as new principles and guidelines in the service. The level of training among respondents was quite high although about 12.2% disclosed that they had never received training. Among those who had some form of training, the areas of training involved health and safety induction course, periodic simulation exercises, and other forms of development programmes.

For an organization to survive and remain healthy in the 21st century, a highly skilled and adaptable work force is fundamental. Many corporations outside the fire service are responding with training practices that prepare employees for global pressures, changing technologies, and increased diversification in the workplace *(Bator, Pesavento, & Ross, 2001*). The fire service is facing these same challenges. Organizations are now meeting challenges by shifting from one-time training events to building a culture of continuous learning within the organization. Progressive organizations identify competencies and develop a plan for each employee so s/he can improve mastery and productivity linked to these competencies.

5.3 Common triggers and types of injuries and disabilities experienced by fire fighters

This study assessed the common triggers and types of injuries and disabilities among firefighters. The knowledge of injury type and common triggers is necessary in developing appropriate policies and interventions to control injury among firefighters. The study outcome showed that most of the injuries that occurred among firefighters were minor injuries. About 48% of these injuries occurred at the fire scene whereas 25.6% occurred on the way to the fire scene and most of them were minor injuries. The outcome was similar to a study by *Karter and Molis (2014)*, where 43.5% of the injuries recorded occurred during fire ground operations and 21.3% per cent during attendance

at non-fire emergencies. The percentage of injuries that occurred on the way to the scene in the study was however high. This was reported by *Karter and Molis* (5.5%). Most common causes of workplace injuries among firefighters have been explosions and transportation incidents *(Clarke and Zak, 1999).* With an improvement in training and provision of requisite clothing and requirement, some of these injuries could be prevented.

Fire fighting injury could result in disabilities, which could result in retirement from the service. Fire fighters were exposed to significant concentrations of hazardous materials including carbon monoxide, benzene, sulphur dioxide, hydrogen cyanide, aldehydes, hydrogen chloride, dichlorofluoromethane, and particulates *(Szubert and Sobala, 2002).* These exposures could even be much damaging when fire fighters do not use protective clothing owing to visual impressions of low smoke intensity leading to direct exposure to these particulates. About 20% of the fire fighters in this study disclosed that their colleagues have become permanently disabled as a result of injuries. Accurate data on injuries and its resulting disabilities is needed to take interventional measures to prevent injuries in fire fighting.

5.4 The occurrence and management of injuries and disabilities

Firefighters engage in an occupation that is characterized by high-stress, high-risk and low-control of the job-related tasks *(Landen and Wang, 2010).* The study assessed the occurrence of injury among firefighters in Ghana. It was revealed that experience of injury was high among the respondents in the study. Majority, 50.8% of the respondents in the study admitted they had ever gotten injured. Organizational response to injury was not very encouraging as reported by respondents in the study. The GNFS paramedic unit offered treatment for only 3.9% of the respondents whereas majority found treatment through other means. The service also catered for only 8.7% of the injuries as indicated by respondents, and majority paid by themselves and through other

means. About 97.2% also disclosed that there was no compensation from the service for the injury and cost involved. Direct and indirect cost of injuries could be crippling to an organization *(NIST, 2004).* The GNFS must have effective response to cost of injuries among staffs. Apart from the cost of treatment and compensation, administrative cost and cost of safety officers are equally important and must be appropriately handled by the service *(NIST, 2004).* Some of the respondents believe that a lot is needed in improving organizational response to injuries. One respondent noted;

> *"Something should be done to the poor organizational structure which has nothing to pay to compensate or refund any health cases and manage injuries*

Majority of respondents in the study could not give precise estimate of how much they spent on treating injury. This could be as a result of non-structural formality for responding to injuries among firefighters. Estimating the cost of injury is however important to give an overview of the economic burden of injuries on the worker, family, organization and nation as a whole. About 14.2% of respondents in this study spent between 100 and GHS 300.00 on injuries.

5.5 Preparedness towards injury prevention and disability care

Adequate preparedness in terms of provision of necessary equipment and protective materials as well as training on injuries among firefighters is necessary to deal effectively with injuries among this group of workers. It should be emphasized again that the risks and contributing factors for firefighter LOD injuries are to be fully understood by firefighters to enable them take preventive measures to avoid injuries, as well as, take the appropriate measure in the course of injuries to prevent disabilities.

The study revealed a low level of training on health and safety among the respondents. Majority, 53% stated that they had never had any form of health and safety training. Knowledge on health and safety is critical in avoiding injury and managing disability and it was expected that most of the respondents would have had training in this area. This was similar to a study done in 2007 in the USA where it was revealed that some of the firefighters lacked formal instructional training in firefighting (NFP, USF and DHS, 2007).Firefighters are action-oriented individuals trained to respond in circumstances in which most people never find themselves. Fire departments and fire training organizations should therefore spend considerable time and money training their staff for performance in the most dangerous of conditions. There is little value for either the individual or the organization if training and education end with only the mastery of the basic fire-fighting skills. Strict prescriptive task performance training narrows the range of effectiveness of the firefighter in the long term, whereas education and development broaden the firefighter's effectiveness *(Duncan, 2000).* The absence of an effective staff development programme limits individual performance, and ultimately the organization will deteriorate *(Senge et al., 1999).*

Surveillance data are generally used to characterize and describe the magnitude and rate of a problem, monitor trends, identify situations that contribute to high numbers or rates, and help guide prevention efforts. This study however revealed that most of the fire stations studied had no form of health surveillance policies. Firefighters regularly respond to hazardous situations that put them at risk for fatal occupational injuries. Traumatic occupational fatality surveillance is a foundation for understanding the problem and developing prevention strategies. This therefore calls for the service to improve efforts at instituting surveillance systems at the various stations. The study also revealed that injury-tracking proramme at the fire stations was very small with about 80% indicating that there existed no such programmes at their stations. These

loop holes in the service are recipe for injury and disabilities and must be given much attention.

Fire fighting has been known to be associated with great fatality. Exposure to dangerous substances has resulted in a higher likelihood of firefighters developing a variety of cancers, *Guidotti and Clough (1992).* The introduction of protective equipment has however made firefighting safer. It is interesting to note however that personal protective clothing was usually inadequate in most of the fire stations as reported by 62.5% of the firefighters interviewed. In the absence of these clothing, fire fighters stand high risk of injury and exposure to radiant heat that can result in skin changes such as erythematic and telangiectasia. Ownership of protective equipment was also low among respondents in this study. Majority of the respondents did not have most of the equipment. About 79.8%, 84.2%, 70.9% and 74.9% did not have thermal protective coat, thermal protective pants, helmet and hoods respectively, and about 64% did not have eye protection equipment while 53.8% also did not have work boots. More efforts is therefore needed to improve supply of equipment to firefighters in the GNFS to enable effective response to injuries.

Firefighting, communication is necessary so that administrators, and workers, may have a clear understanding of the hazards associated with their work duties. In this study, majority of the respondents were in agreement that increased efficiency and communication about the circumstance and causes of injuries and near misses would affect their safety as an individual fire fighter. Reasons cited by some of the respondents included personnel becoming aware of the causes and circumstances that lead to injuries, educating personnel on safety and injury matters and alerting them to know the job professionally.

There is also the need for communication of injuries to management or leadership. As reported by *Krause et al (2010),* senior leadership familiarity or knowledge of their

company's injury history (like employee names and the details of the injury event) is positively correlated to low occupational injury rates. However, about 53% of the respondents in this study bemoaned the lack of injury-related communication within the GNFS, which may negatively impact fire fighter safety. Some respondents explained that communication is important in teamwork and lack of communication might cause more injuries. Others also indicated that training on injury-related communication would improve their skills on the job.

5.6 Factors which influence injury or near-miss reporting system

5.6.1 Socio-demographic factors

The study further assessed the influence of socio-demographic characteristics on experience of injuries among firefighters. The study revealed an influence of length of service and educational background on injuries. The mean length of service was higher among those who experienced injury as compared to those who had never experienced injury and the percentage of staff who experienced injury being significantly higher among those who had NVTI qualification, and lower among those with university or post-secondary degree ($p<0.001$). The age of the respondents did not have influence on injury in this study. This is consistent to the study by *Szubert and Sobala (2002)*, which did not find any link between injuries and the age of firefighters.

5.6.2 Influence of level of preparedness and ownership of protective equipment on injury among fire fighters

The study also revealed an influence of level of preparedness on injuries among firefighters. According to the study univariable results, presence of surveillance policy and personal protective clothing had significant influence on injury among firefighters. Experience of injury was also higher among respondents who stated that their fire stations had no health surveillance policies. This also shows the importance of effective

surveillance policies as well as equipping the service in helping to minimize injuries. Surveillance systems help to monitor minor accidents and near misses allows organizations to adjust safety policies and procedures and possibly prevent future incidents *(Lauver et al., 2009).* These help to indicate problem areas and identify systems that need improvements. Organizations with very low frequencies of accidents and injuries have processes in place that allow them to develop new rules and procedures when faced with unexpected or undesirable results. As indicated by *Maher and Casamayou (2009),* making policy, rule, and standard operating procedure changes based on injury and accident data is recognized as one of the first steps towards organizational learning. There is therefore an urgent call on the GNFS to ensure effective health surveillance systems in all fire stations.

Further, experience of injuries was higher among firefighters with inadequate protective clothing. As shown in earlier discussions, majority of respondents in this study had no personal protective clothing. Long-term prevention, health promotion, and technological advancements certainly equip firefighters with individual and sometimes unit-level tools to reduce on-duty risks before an incident occurs. This study also revealed the importance of protective equipment in reducing injury at the workplace. As shown in the study, ownership of all the equipment studied, with the exception of work boots significantly influenced experience of injury among firefighters. Experience of injuries was significantly lower among respondents who owed thermal protective coat, thermal protective pants, gloves, helmet, hood and eye protection.

Respondents who had safety training were less likely to have injury as compared to those who did not have any form of training on health and safety. This shows that improved efforts in training firefighters regularly could yield a positive impact of minimizing injuries. This is consistent with the report from the study by Wong et al (2005), which indicated that formal and repeated training efforts based on past

experiences lead to low organizational accident and injury rates.In the multivariable analysis where the socio-demographic, health safety training still had a significant influence on experience of injury among fire fighters with personnel who had no safety training have increased risk of experiencing injuries as compared to those who had safety training.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.0 Introduction

This chapter presents the conclusions of the study and recommendations for policy improvement to help minimize occupational injuries among fire fighters in Ghana.

6.1 Conclusion

This study was conducted in order to identify common triggers and types of injury and disabilities and their implications on operational fire fighters in Ghana. The study also looked at the level of preparedness of the GNFS in times of policy and availability of tools and equipment in managing injury.

6.1.1 Trend and type of injuries

The outcome of this study suggests that most of the injuries fire fighters encounter is minor and they occur at the fire scenes and on the way to fire scene. Injuries, which occur on the way to fire scene, are mostly road accidents, and this could be an indication of a gap in knowledge of awareness among road users or lack of expertise among drivers from the GNFS. The study also shows that some of the injuries suffered among fire fighters have resulted in disabilities and some of these were not recalled into the services. There is the need for proper disability retirement packages to cater for these cases.

6.1.2 The occurrence and management of injuries and disabilities

The study further showed a high level of injury among firefighters. About 51% of the respondents in this study admitted they had ever experienced injury. Management of injury was however poor with only less than 10% being catered for by the service, and most of them not receiving any compensation from the service for the injury and cost involved. There was also lack of information on the cost of injury to the personnel as well as the entire service.

6.1.3 Preparedness towards injury prevention and disability care

It can be concluded from this study findings, that the level of preparedness to prevent and manage injuries in the GNFS is low. Majority of interviewed fire fighters had not had safety training, most of fire stations lacked surveillance systems, inadequacy of injury tracking programmes in the service with most fire stations lacking and most fire fighters lack personal protective clothing like thermal protective coat, thermal protective pants, helmet and hood.

6.1.4 Factors which influence injury or near-miss reporting system

This study showed the influence of age, education, presence of surveillance policy and personal protective clothing had significant influence on injury among firefighters, participation in health safety training and ownership of some protective clothing on experience of injuries in the univariable analysis. When all the variables were adjusted for however, only health safety training remained significant. This suggests the importance of safety training in minimizing injury occurrence among fire fighters.

6.2 Recommendations

Based on the findings from this study, the following recommendations are made to improve the current situation and help improve injury management within the GNFS.

6.2.1 Government of Ghana

- The Government must improve budgetary allocation to the GNFS to ensure improvement in tools and equipment needed in effective fire management to minimize injury among personnel.
- The provision of support must go hand in hand with effective supervision of the service to ensure that all requisite policies are in place to effectively manage injuries and disabilities.
- Funding for GNFS comes from the Government of Ghana's Consolidated Fund, covering the following four main items:

    i. Item One- personnel emolument expenses

    ii. Item Two- Administrative expenses iii.

    Item Three-Service expenses, and iv. Item

    Four– Investment expenses

Government should therefore ensure continuous and sustainable provision of adequate funds for the GNFS.

6.2.2 Ghana National Fire Service

- Accurate data on injuries and its resulting disabilities is needed to take interventional measures to prevent injuries in fire fighting. The data and record keeping systems should be improved in the service.
- Record specifics on injury type, location, and common equipment involved to trend and prevent future occurrence should be designed and established appropriately.
- The study showed that some injuries among fire fighters result in permanent disabilities. This implies that there is the need to institute appropriate pension schemes to cater for early retirement from the service due to disabilities resulting from injury during duty in the service.

- Data on cost of injuries due to fire fighting was also lacking in the service. This should be a major priority of the GNSF as this data is required in estimating the burden of injuries to the service and nation at large.
- The risk of injury experience was shown to be higher among personnel who did not have protective clothing. The service should also ensure that there are appropriate and adequate protective clothing at all fire stations.
- To ensure that Firemen are appropriately dressed in protective clothing during fire fighting to enable them fight fires confidently, its recommend that, GNFS evaluates its logistic needs especially protective gears and discuss with the Parliamentary select Committee on Defence and Interior to assist the Service procure the required quantity and quality of protective clothing for firemen.
- GNFS has a training academy to offer theoretical and practical training for personnel in fire fighting and rescue services. The essence of theory and practical drills is to equip firemen with the knowledge and ability to fight fires. On the other hand, continuous training in Health and Safety Management is essentially to enable the Service to have serving personnel who are capable of carrying out its core function of fighting fires. Among others, the training will enable staff of the Service to know:
    - the type of equipment to use for what category of fire, and
    - how to position oneself and fire fighting equipment, especially tenders, in fire emergencies to minimise injuries and destruction to equipment.

6.2.3 Fire service Personnel

- Use of protective clothing should be an utmost priority among fire personnel. There is the temptation to disregard this especially in situations where the fire situation is not grievous on eye observation. This however could still be threating to one's health.

- Fire personnel must also ensure that all injuries during service duties are reported.

6.2.4 Recommendation for further research

 Further research on the outcome of injuries and disabilities is recommended across all fire stations in the country. It is also recommended that and in-depth study be conducted to ascertain the cost of injury and disabilities associated with fire operations in the country.

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APPENDICE

APPENDIX A

ASSESSEMENT OF OCCUPATIONAL RELATED INJURIES AND DISABILITIES AMONG OPERATIONAL FIRE FIGHTERS IN GHANA

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNLOGY,

SCHOOL OF MEDICAL SCIENCES

DEPARTMENT OF COMMUNITY HEALTH

Research Title:

Questionnaire for.....

QUESTIONNAIRE FOR OPERATIONAL FIRE FIGHTERS

Dear respondent,

I am a student of Kwame Nkrumah University of Science and Technology pursuing Master of Science in Public Health degree in Health Services Planning and Management. I am conducting a study to assess the occupational related injuries and disabilities among the Operational Fire fighters in Ghana.

The study will enable administration and management of the fire service interventions which would improve the health and safety of personnel within the service.

Could you please complete the questionnaire below to assist in this project? Your consent is required in the filling of this questionnaire and you are allowed to dissent for reasons which you are not under any compulsion to disclose. Your confidentiality is assured. No responses would be linked to you in person.

THANK YOU.

SECTION A: SOCIO-DEMOGRAPHIC DATA

1. What is your role in the service?

a. Operational Fire Fighter

b. Training Officer

c. Watch/Crew Leader

d. Paramedic

e. Other (specify)…….

2. How long have you been in practice as a professional? .....
3. What is your age please? .....
4. What is your level of education? (Be specific please)…….....
5. What department/unit do you work?
    a. Operational Directorate
    b. Other department/unit/directorate (Specify) ……
6. How long have you worked in your current unit/department/directorate? ……
7. Are you enrolled in the NHIS?

SECTION B: Common triggers and types of injuries and disabilities.

SECTION C: Mechanisms through which Injuries and disabilities occur

SECTION D: Factors which influence injury or near-miss reporting system

SECTION E: Effects associated with injuries and disabilities.

SECTION B: PREPAREDNESS TOWARDS INJURY PREVENTION AND DISABILITY CARE

8. What level of training have you received in the current unit of your work?

    a. Health and Safety Induction course

    b. Regular in-service and refresher courses

    c. Periodic Simulation exercises

    d. No training

9. Fire fighting and related emergency service delivery begins with its preparedness.

    a. Agree

    b. Do not agree

    c. Do not know

10. Emergency preparedness and injury prevention is a strategic planning and decision making process.

    a. Agreed

    b. Do not agree

    c. Do not know

11. Prevention of injuries and disability avoidance requires resources mobilization and allocation.

    a. Agreed

    b. Do not agree

    c. Do not know

12. The major components of injury prevention and disabilities include; adequate and well trained fire fighters, standard personal protective equipment, efficient injury and near-miss reports, and common standard operating procedures.

    a. Agreed

    b. Do not agree

    c. Do not know

13. Have you ever gotten injured? Yes/ No

14. Where were you injured?

a. At the fire scene
b. On the way to the fire scene
c. During training or a simulation exercise
d. When returning from fire fighting

15. Have you ever experienced any major injury? Yes/No

16. Have you ever experienced any minor injury? Yes/No

17. How did you treat the injury? ?(Briefly explain)

……

……

……

18. Who borne the cost of the injury?

a. The fire service
b. Personal
c. Other……

19. Was there any form of compensation? Yes/No

20. Have you ever had any form of health and safety training? Yes/No

21. How often do your fire stations undertake health and safety training?

a. Annually
b. Quarterly
c. Monthly
d. Weekly
e. Daily

22. Does your station have any form of health surveillance policy? Yes/No

23. Are your usual personal protective equipment adequate and efficient? Yes/No

24. Does your fire station have any form of standard operating procedures? Yes/No

25. Does your fire station have any injury tracking programs? Yes/No

26. Have any of your colleagues become permanently disabled? Yes/No

27. How many of them do you recall? ?(Briefly explain)

……

……

28. Do you think that increased efficiency and communication about the circumstance and causes of injuries and near-misses would affect your safety as an individual fire fighter? ?(Briefly explain)

……

……

……

.....

29. Based on your career experiences, are you concerned that lack of injury-related communication within the GNFS may negatively impact fire fighter safety? ?(Briefly explain)……

……

……

30. Are there any issues I have left out which you would want us to discuss?(Briefly explain)……

……

……

……

THANK YOU VERY MUCH!!!!!

APPENDIX B

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

ASSESSEMENT OF OCCUPATIONAL RELATED INJURIES AND DISABILITIES AMONG OPERATIONAL FIRE FIGHTERS IN GHANA

QUESTIONNAIRE FOR STAFF MEMBERS OF PARAMEDIC UNITS

Dear respondent,

I am a student of Kwame Nkrumah University of Science and Technology pursuing Master of Science in Public Health degree in Health Services Planning and Management. I am conducting a study to assess the occupational related injuries and disabilities among the Operational Fire fighters in Ghana.

The study will enable administration and management of the fire service interventions which would improve the health and safety of personnel within the service.

Could you please complete the questionnaire below to assist in this project? Your consent is required in the filling of this questionnaire and you are allowed

to dissent for reasons which you are not under any compulsion to disclose. Your confidentiality is assured. No responses would be linked to you in person.

THANK YOU.

SECTION A: SOCIO-DEMOGRAPHIC DATA

1. What is your role in the service?

   Operational Fire Fighter

   Training Officer

   Watch/Crew Leader

   Paramedic

   Other (specify)…….

2. How long have you been in practice as a professional? .....
3. What is your age please? .....
4. What is your level of education? (Be specific please)…….....
5. What department/unit do you work?

   Operational Directorate

   Other department/unit/directorate (Specify) …… 6.

How long have you worked in your current unit/department/directorate?

…….....

SECTION B: PREPAREDNESS TOWARDS INJURY PREVENTION AND DISABILITY CARE

7. What was the rationale for the setting up of the Paramedic Unit of the Ghana National Fire Service?(Briefly explain)…….....

   ……

   ……

……

8. When was the paramedic unit established?.....
9. Under which Chief Fire Officer's tenure Paramedic Unit setup, if any?

   .....

10. What is the capacity of the paramedic unit?
    a. Bed……
    b. Personnel……
11. What is the main crux of the policy guiding the establishment of the paramedic unit of the GNFS?(Briefly explain)

    ……

    ……

    ……

12. Does the emergency unit have any standard of practice (SOP)?
    a. Yes
    b. No
    c. No idea
13. What is the staff strength required for the emergency unit: doctors, nurses, pharmacist and paramedical staff?(Briefly explain)

    ……

    ……

14. What staff strength do you have in the unit (Number of health professionals)?(Briefly explain

    ……

    ……

    ……

15. Is the staff strength in this unit adequate?

a. Yes

b. No

16. What is it that could be done, to address the challenge of inadequate staff strength in this unit? (Briefly explain)

……

……

……

17. Do you have an idea of how many patients have been seen in the past year at the emergency unit of the hospital?

a. Yes

b. No

18. In your opinion, is the paramedic unit of the GNFS fulfilling its mandate in terms of managing emergency cases?

a. Yes

b. No

c. Averagely

19. What is the situation like, in terms any financial gains or losses as a result of patient load at the A&E unit, of the unit?(Briefly explain)

……

……

……

20. What are the plans for managing multiplied casualty in the paramedic unit of the (Emergency Preparedness Plan)?(Briefly explain)

……

……
……

……

21. What are your projections of the paramedic unit in the next five (5) years?(Briefly

explain).....……

……

……

22. What do you think about service delivery and efficient management of resources at the paramedic unit?(Briefly explain)

…….....……

……

……

23. Are there any issues I have left out which you would want us to discuss?(Briefly explain

……

……

……

24. Are there any issues I have left out which you would want us to discuss?(Briefly

explain)……

……

……

……

THANK YOU VERY MUCH!!!!!

APPENDIX C

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

ASSESSEMENT OF OCCUPATIONAL RELATED INJURIES AND DISABILITIES AMONG OPERATIONAL FIRE FIGHTERS IN GHANA

INTERVIEW GUIDE FOR REGIONAL TRAINING OFFICERS

Dear respondent,

I am a student of Kwame Nkrumah University of Science and Technology pursuing Master of Science in Public Health degree in Health Services Planning and Management. I am conducting a study to assess the occupational related injuries and disabilities among the Operational Fire fighters in Ghana.

The study will enable administration and management of the fire service interventions which would improve the health and safety of personnel within the service.

Could you please complete the questionnaire below to assist in this project? Your consent is required in the filling of this questionnaire and you are allowed to dissent for reasons which you are not under any compulsion to disclose. Your confidentiality is assured. No responses would be linked to you in person.

THANK YOU.

SECTION A: SOCIO-DEMOGRAPHIC DATA

1. What is your role in the service?

a. Operational Fire Fighter

b. Training Officer

c. Watch/Crew Leader

d. Paramedic

e. Other (specify)…….

2. How long have you been in practice as a professional? .....

3. What is your age please? .....

1. What is your level of education? (Be specific please)…….....
2. What department/unit do you work?
    c. Operational Directorate
    d. Other department/unit/directorate (Specify) …… 3. How long have you worked in your current unit/department/directorate?

    …….....

SECTION B: PREPAREDNESS TOWARDS INJURY PREVENTION AND DISABILITY CARE

4. As a training officer how often, do you conduct training sessions for the operational fire fighters and other auxiliary staff?
    a. Annually
    b. Quarterly
    c. Monthly
    d. Weekly
    e. Daily
    f. Other.....
5. What are your usual needs analyses for conducting training programs?
    a. Near-misses
    b. Injuries
    c. Accidents
    d. Other
6. How do you design the training programs? (Briefly explain)

    ……

……

……

7. Have you ever experienced injuries during training sessions? Yes/No

(Briefly explain)

……

……

……

8. How do you normally facilitate the training programs?

i. Power point presentation Yes/No ii.

Practical Demonstration Yes/No iii.

Familiarization of Equipment Yes/No

iv. Other.....

9. Do you usually develop ex-ante risk assessment procedures towards training sessions? Yes/No (Briefly explain)

……

……

……

10. What are staff members' responses to training sessions?

i. Positive ii.

Negative iii.

Other

(Briefly explain)

……

……

……

11. Do you usually achieve training objectives? Yes/No
12. Are there any forms of sanctions or punitive measures for failure to attend training sessions by any staff member? Yes/No
13. How do you monitor and report on post-training sessions to authorities? (Briefly explain)

    ……

    ……

    ……

14. Are there any issues I have left out which you would want us to discuss?(Briefly explain)

    ……

    ……

    ……

THANK YOU VERY MUCH!!!!!

APPENDIX D

GHANA NATIONAL FIRE SERVICE

GREATER ACCRA REGIONAL HEADQUARTERS

(KORLE-BU)

In case of reply the Number & Date of this Letter should be quoted

My Ref. No. GFS/GAR/GF 04046D/30

Your Ref. No.....

P. O. Box GP 18746
Accra, Ghana.
Tel/Fax: 0302-662397
Tel: 0302-662583
0302-968490
0302-662786
0302-662585
Emergency: "192"

11 MARCH 2014

TO WHOM IT MAY CONCERN

LETTER OF INTRODUCTION
DO.III CARLIS PAITOO – SVC. NO. GF 04046D

The above mentioned Officer has gained a scholarship to pursue Masters in Public Health in injury Control at KNUST, Kumasi.

As part of his academic exercise, he is to research into occupational injuries and diseases confronting Operational Fire Fighters in Ghana.

By this letter, he is to be assisted to gather the needed data.

You are therefore entreated to give him all the necessary help to make his work successful.

P. K. DONKOR (ACFO)
2IC
For: REGIONAL FIRE OFFICER

eet

APPENDIX E

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY
COLLEGE OF HEALTH SCIENCES
SCHOOL OF MEDICAL SCIENCES
DEPARTMENT OF COMMUNITY HEALTH

13th March, 2014

The Chairman
The Committeee on Human Research,
Publications and Ethics
KNUST – SMS/KATH
Kumasi

Dear Sir

LETTER OF INTRODUCTION

This is to introduce to you Osafo Carlis – Paittoo Ben an MPH Health Services Planning and Management student from the Department of Community Health, School of Medical Sciences, Kwame Nkrumah University of Science and Technology.

He is undertaking a study titled *"Assessment of Occupational Related Injuries and Disabilities among Operational Firefighters in Ghana"*.

As the academic supervisor to Osafo Carlis – Paittoo Ben who is undertaking the study as part of the requirements for the award MPH Health Services Planning and Management, I write in support of the study.

We urge your support for this thesis.

Sincerely,

Dr. Peter Agyei Baffour
SUPERVISOR

Private Mail Bag, University Post Office, Kumasi, Ghana. Phone: 233-03220-60293. Telex: 2555 UST (GH)
Fax 233-3220-60302. E-mail: ustlib@libr.ug.edu.gh website: www.knust.edu.gh

APPENDIX F

Near Miss / Incident / Accident Report & Investigation Form

1. **Person(s) Involved**:

   Name: _____

   Contact No: _____ Department / Section: _____

   Employee: ☐ Student: ☐ Contractor: ☐ Other (Specify): _____

2. **Details of near miss / incident / accident**:

   Location: _____

   Date: _____ Time: _____ am / pm

3. **Severity**:

   Fatal ☐ Serious Harm ☐ Minor Harm ☐ No Harm / Near Miss ☐

4. **Treatment**:

   Nil ☐ First Aid ☐ H&CC ☐ Doctor ☐ Hospital ☐

   What treatment was given ? _____

   _____

   By Whom _____

5. **Description of what happened**: _____

   _____

   _____

   _____

6. **Describe the cause of the near miss / incident / accident**: _____

   _____

   _____

   Contributory Factors (refer to these when identifying the cause of the near miss / incident / accident)

   Immediate Causes
   - Guarding
   - Defective tools or equipment
   - Hazardous arrangements
   - Unsafe conditions
   - Unsafe design
   - Housekeeping
   - Environmental conditions

   Substandard Acts
   - Operating without authority
   - Disabling safety devices
   - Using unsafe equipment
   - Non use of Personal Protective Equipment
   - Non use of lock out / isolation systems
   - Unsafe positioning
   - Distraction / fooling about

Please complete the other side of this form

7. **Has a significant hazard been identified ?** Y / N

   If yes, please investigate this hazard and update the Hazard Register in your department or section accordingly

8. **Chance of the near miss, incident or accident recurring**:

One off ☐ Daily ☐ Weekly ☐ Monthly ☐ 6 Monthly + ☐

9. **Corrective Action**: (What will be done to *minimise the risk of this happening* again)

Action	By Whom	Completed

Person in control of the workplace: Name: _____

Signed: _____ Position: _____

10. **Manager's Comments**:

_____

_____

_____

_____

Signed: _____ Position: _____

Date: _____

11. **Health and Safety Co-ordinator's comments**:

_____

_____

_____

_____

Is post critical event testing required Y / N

If yes, advise Occupational Health Nurse Y / N Date: _____

12. **Near Miss / Incident / Accident recorded on Accident Register and all corrective actions completed**:

Signed: _____ Date: _____

Retain a copy on the department / section file
Send completed original to Health and Safety Co-ordinator

APPENDIX G


REGIONAL AND DISTRICT FIRE STATIONS, FIRE POSTS AND PROPOSED FIRE STATIONS
BAWKU
NANDOM
Tumu
NAVRONGO
BONGO
ZEBILA
LAWRA
UPPER WEST
SANDEMA
BOLGA
UPPER EAST
JIRAPA
GAMBAGA
NABAWLI
WALEWALE
WA
NOTHERN
CHEREPONI
SAYEZUGU
GUSHEGU
TOLON
TAMALE
YENDI
ZABZUGU
BOLE
YEIPE
DAMONGO
BIMBILA
SALAGA
NKWANTA
YEJI
DAMBAI
SAMPA
NSAWKAW
KINTAMPO
KETEKRACHI
JAPEKROM
WENCHI
BRONG - AHAFO
NKORANSA
ATEBUBU
VOLTA
TECHIMAN
BERE KUM
SUNYANI
NKENKAQU
EJURA
JASIKAN
DUAYAW NKWANTA
MAMPONG
DONKORKROM
HOHOE
HWIDIEM
TEPA
OFINSO
ACONA
NKONYA AHENKRO
ADUAMOA
KPANDO
ASHANTI
KORANGO
NKAWKAW
BEGORO
AHAMANSO
HAVE
HO
KUNTONASE
BEKWAI
AKODOMBO
PEKI
KEJETIA
EASTERN
KIBI
KRONGU
SEFWI WIAWSO
OBUASI
KADE
AKWATIA
KOFORIDUA
AKASI
ADAWOME
ABOR
SUHUM
AKUAPEM-MAMPONG
ASANKRAGUA
DUNKWA-ON-OFFIN
ACHIASE
SEGAKOPE
AVE VIME
PENYI
EKROPONG
NSAWAM
DOBOMA
CAMBRABOI
PRESTEA
TARKWA
ESIKUMA
GREATER ACCRA
OLD NINGO
ADA
ANLOGA
KETA
CENTRAL
SWEDRU
TEMA
NUNGUA
WESTERN
DAGOASE
ACCRA
ACCRA CITY
HQ SUB-STATION
MADINA
KORLE GONO
INDUSTRIAL AREA
DANSOMAN
WINNEBA
APAM
CAPE COAST
REGIONAL FIRE STATION
DISTRICT FIRE STATION
FIRE POST
PROPOSED FIRE STATION