AN INVESTIGATION INTO THE PREVALENCE AND RISK FACTORS OF OCCUPATIONAL MUSCULOSKELETAL INJURIES IN FIREFIGHTERS IN THE DURBAN METROPOLITAN FIRE DEPARTMENT

By

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Dissertation submitted in compliance with the requirements for the Masters Degree in Chiropractic at the Durban University of Technology

I, Dhimunthree Albert, do declare that this dissertation is representative of my own work in both conception and execution and that the use of work by others has been duly acknowledged in the text.

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DEDICATION

This dissertation is dedicated to the Supreme Personality of Godhead, Lord Krishna. Thank You…for listening to my ramblings and fears…for subduing my self-doubt, showing me that I can do anything through hard work, perseverance and with you by my side…and for carrying me through some of the darkest times of my life. My eternal gratitude and service would never be enough to repay You for giving me strength and companionship when I need it the most.

Their Lordships Sri Sri Radha Shyamasundara

Hare Krishna Hare Krishna Krishna Krishna Hare Hare

Hare Rama Hare Rama Rama Rama Hare Hare

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What is a firefighter?

He's the guy next door....

He's a guy like you and me with warts and worries and unfulfilled dreams.

Yet he stands taller than most of us.

He's a fireman....

A fireman is at once the most fortunate and the least fortunate of men.

He's a man who saves lives because he has seen too much death.

He's a gentle man because he has seen the awesome power of violence out of control.

He's responsive to a child's laughter because his arms have held too many small bodies that will never laugh again....

He doesn't preach the brotherhood of man.

He lives it.

~Author Unknown

ABSTRACT

Occupational injuries sustained by Emergency Rescue Care workers have been well documented. However, despite their high rates of injury, the literature regarding the risk factors for work-related musculoskeletal injuries (WRMSIs) in the fire service has not been well-established, especially in South Africa.

***Objectives*:** To determine the prevalence and risk factors for musculoskeletal injuries in the Durban Metropolitan Fire Department and to evaluate the relationship between selected risk factors and the prevalence of musculoskeletal injuries.

Methods: This was a descriptive study from a large urban Fire Department employing 350 active firefighters. Using a cross sectional study design, a retrospective analysis investigated the musculoskeletal injury prevalence from 2006-2008 by means of a questionnaire. Individuals reported on demographics, injury location, injury etiology, injury nature, extent of treatment rendered and time lost from work. Additionally, data was obtained regarding smoking, occupational stress, fitness, protective gear and injury prevention advice given by the Durban Metropolitan Fire Department. A 41% response rate was achieved.

Results: The point prevalence of WRMSIs was 33.6% and the period prevalence was 81.1% of the sample. Low back injuries (47.9%) and strain injuries (40.8%) were the most common, followed by knee (22.5%), shoulder (19.7%) and ankle injuries (19%). The most common causes included lifting heavy objects, working in awkward postures and running. Weight, ethnic group, stress, lack of nutritional advice and alcohol consumption were all significantly associated with the prevalence of injuries. Ex-smoking was significant in the prevalence of low back injuries, stress was significant in the prevalence of knee injuries and alcohol consumption was associated with the prevalence of shoulder injuries.

Conclusion: WRMSIs are of great concern in the fire service as their prevalence is substantial. Evaluation and implementation of further preventative measures and advice based on the results of this study can be effective in reducing WRMSIs.

DEFINITIONS

Aerobic exercise:

Exercise in which energy needed is supplied by oxygen inspired and is required for sustained periods of vigorous exercise with a continually high pulse rate (Quinn, 2008).

Alcoholic myopathy:

Alcoholic myopathy is characterized by a reduction in skeletal muscle protein synthesis, total RNA and protein content and the myofibrillary protein contents (Slavin *et al.,* 1983; Preedy and Peters, 1988; Reilly *et al.,* 2000).

Body Mass Index (BMI):

BMI is a measure of body fat based on an adult's height and weight. It is used to screen for weight categories that may lead to health problems. According to the Centres for Disease Control and Prevention, a BMI below 18.5 is considered underweight, 18.5-24.9 is normal; 25-29.9 is overweight and over 30 is obese (Pollack *et al.,* 2008).

Chain of Command:

This is a pathway of responsibility from the highest level in the fire service to the lowest level (IFSTA, 1998).

Concurrent Validity:

This is measured when a particular tool produces similar results when compared with another tool already known to be trustworthy (Bernard, 2000). This is also called *criterion* validity by Mouton (2002).

Content Validity:

An instrument in which the content is considered effective to be able to assess a particular theory (Bernard, 2000).

Contusion:

An injury to a muscle and tissues caused by a blow from a blunt object, typically resulting in a bruise (Quinn, 2008).

Construct Validity:

This measures how accurately answers to questions in a scale reflect theoretical predictions of a particular construct (Bernard, 2000, Raftery *et al.,* 2002).

Dehydration:

A lack of an adequate amount of fluid in the body; may be accompanied by dry mouth, thirst, constipation, concentrated urine or fever. Dehydration occurs when a person's body water content has decreased to a dangerously low level (Quinn, 2008).

Extrication:

A life-threatening situation which involves the removal and treatment of victims who are trapped by some sort of man-made machinery or equipment (International Fire Service Training Association (IFSTA), 1998).

Face Validity:

This is determined by an agreement between researchers and those with a vested interest in the questionnaire, that on "the face of it" the tool seems valid (Bernard, 2000; Raftery *et al.,* 2002).

Firefighter[1]:

Main duties of a firefighter include (Guidotti, 1998; George, 2007, Bateman, 2007):

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[1] *In the reviewed literature, fire service personnel are termed as either "fire-fighter" or "firefighter." In this dissertation, "firefighter" will be used, unless otherwise quoted. Furthermore, in this study male pronouns are used to describe both male and female firefighters purely for brevity and are not intended to offend female firefighters.*

- Respond to fire alarms, oil spillages, accidents (automobile, industrial, aviation and ship), building collapses and acts of nature (floods, mudslides and fires due to electric storms).
- Rescue victims.
- Control fire and extrication of casualties using various equipment and methods (axes, water, chemical extinguishers, ladders, vehicles, boats, etc).
- Use proper techniques for first aid.
- Provide safety education to the public.

Fireground:

The site of the fire (Rose, 1996) and includes structure fires, vehicle fires, bush fires as well as ship and oil fires and refers to all activities from the moment of arrival at the scene to departure time (e.g., setup, extinguishment, overhaul) (Karter and Molis, 2004).

Fitness:

"…the ability to perform your daily job with sufficient reserve to respond to unforeseen emergencies. Physical fitness has a number of subcomponents, but they can be divided into three general areas: aerobic or cardiovascular; muscular fitness and body composition." (Davis and Dotson, 1991)

Heat Stroke:

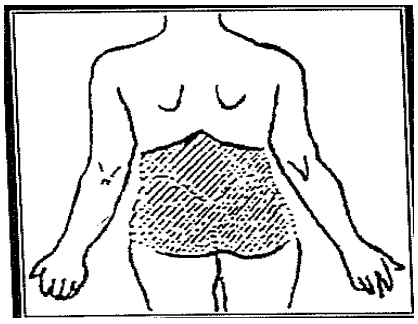
Condition of rapidly rising internal body temperature that overwhelms the body's mechanisms for release of heat and could result in death if not cared for appropriately (Quinn, 2008).

Inflammation:

The body's natural response to injury in which the injury site might display various degrees of pain, swelling, heat, redness and/or loss of function (Quinn, 2008).

Mechanical low back pain (LBP):

Kirkaldy-Willis and Bernard (1999) describe low back pain as any acute or chronic pain, stiffness or ache that affects the lower part of lumbar region of the back.



Picture by Kuorinka *et al.* (1987)

In addition, Borenstein *et al.* (1995) describes mechanical LBP as LBP of a musculoskeletal origin, either due to overuse of a normal anatomical structure (e.g. muscle strain) or due to injury or deformity of a normal anatomical structure (e.g. a herniated intervertebral disc)."

A more recent definition defines low back pain as pain that extends from the thoracic diaphragm to the pelvic diaphragm (noted as the area on the body surface being between the 12^{th} ribs bilaterally and the gluteal folds bilaterally) (Nyland and Grimmer, 2003).

Musculoskeletal Injury (MSI):

MSI is an umbrella term for a number of injuries and disorders of the muscles, nerves and supporting structures (e.g. intervertebral discs) (Hagberg *et al.,* 1995; Kessler *et al.,* 2003).

Obesity:

Obesity occurs when a person has too much body fat. Obesity is not the same as being overweight; a person is considered obese when they weigh 20% or more of the maximum desirable weight for their height (Quinn,

2008). A person with a BMI over 30 is classified as obese (Pollack *et al.,* 2008).

Occupational disease:

Defined as a disease for which there is a direct occupational cause-effect relationship between hazard exposure at work and disease e.g. Smoke inhalation and lung disease (Armstrong *et al.,* 1993)

Overhaul:

The National Fire Protection Association (1999) in the United States describes the overhaul activities as the:

- Determination of structural stability.
- Location of hidden fires.
- Exposure of hidden fires by opening ceilings, walls, floors and by pulling apart burned materials.
- Separation, removal and relocation of burnt material to a safe area while cordoning off the area of origin for determination of the cause of the fire.
- Removal of fire debris and routing of water from the structure.
- Covering or closing of building openings, doors, windows, floors and roofs.
- Provision of security and surveillance for the public if there is a possibility of a secondary fire.

Overuse Syndromes:

A result of repetitive stress to body structures (Quinn, 2008).

Point prevalence:

The number of persons with a given disease, condition or other attribute during a specified point in time (Gerstman, 2003).

Period prevalence:

The number of persons with a given disease or condition or other attribute over a specific period of time (Gerstman, 2003).

Prevalence:

Is defined as the proportion of people in a given population that have a symptom or disease at a particular time (Borenstein *et al.,* 1995).

Risk factor:

Characteristics (e.g. ethnicity, gender, age, height, obesity) or variables (e.g. smoking, occupational exposure levels) associated with increased probability of a toxic or adverse health effect (Karwowski and Marras, 1999).

Self-Contained Breathing Apparatus (SCBA):

Oxygen-containing cylinder utilized by firefighters to protect their face and respiratory tract from toxic products of combustion (IFSTA, 1998).

Sprain:

Injury resulting from the stretch or twist of the joint and causes various degrees of stretch of tear or a ligament or other soft tissue supporting the joint (Quinn, 2008).

Stress:

Fishkin (1989) defines stress as the result of any demand, either internal, external or both, that causes a person mentally and physically to readjust in order to maintain a sense of balance.

Strain:

A strain occurs when a muscle becomes overstretched and tears. This painful injury, also called a "pulled muscle," can be caused by an accident, improper use of a muscle, or overuse of a muscle (Frontera and Silver, 2002; Marx *et al.,* 2002; Delee *et al.,* 2003).

Stretching:

Any therapeutic maneuver designed to elongate shortened soft tissue structures and thereby increase flexibility (Quinn, 2008).

Work-related musculoskeletal injuries (WRMSIs):

Boudreaux and Wright (2003) and the World Health Organization (2003) recognize MSIs as being work-related when performance of work activities and the work environment play a significant role in the development of an injury.

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CHAPTER 1: INTRODUCTION

1.1. INTRODUCTION

This chapter discusses the background of the study followed by the problem statement, aim, objectives, limitations and significance of the study.

1.2. BACKGROUND TO THE PROBLEM

Firefighters have a number of occupational risk factors that are listed in the literature for the development of WRMSIs (Nuwayhid *et al.,* 1993; Reichelt and Conrad, 1995; Guidotti, 1998). Due to the nature of their occupation, firefighters face an increased risk of cardiovascular disease, post-incident psychological stress and strain injury of the musculoskeletal system due to improper lifting (Guidotti, 1998). A review of the literature has resulted in the focus of this study on the contributing factors of WRMSIs in firefighters.

The following factors were taken into consideration in this study:

- ***Physical fitness***

  The unique nature of the firefighter's occupation requires an exceptional level of physical fitness. From a public administration perspective, firefighter physical fitness is important for many reasons- mainly, the well being and safety of the firefighter. This is equated to the ability of a firefighter to do his job; therefore a firefighter's fitness level impacts directly on public safety. An unfit firefighter is a liability to the public, his co-workers and himself (Rose, 1996). However, studies internationally indicate that there is a high incidence of obesity, sedentary lifestyles, dyslipidaemia, hypertension, as well as chronic musculoskeletal conditions among firefighters (Aronson, *et al*., 1994; Reichelt and Conrad, 1995; Guidotti, 1998).

- ***Protective gear***

  All firefighters have to wear protective clothing commonly called “turn out gear.” Together, this protective gear and a SCBA weigh between 20-25 kilograms (Gilman and Davis, 1993; George, 2007). In addition to being heavy, the protective gear is bulky, traps body heat and most importantly, restricts movement, resulting in an increased risk of injury (Louhevaara, 1984; Sykes, 1993; Love *et al.*, 1994; Rose, 1996; Donovan and McConnell, 1998).

- ***Occupational stress***

  Stress and accompanying depression in the workplace is the second most disabling illness affecting workers after heart disease (Shantz, 2002).

  Fire fighters are exposed to critical events where there is often a grave or uncertain danger. Exposure to serious traumatic events (or consequence of such events) is cause of occupational stress (Hildebrandt, 1984; Blum, 1994). Firefighters have a high level of public responsibility, work long shifts and they work in a uniquely stressful environment. Many firefighters have reported the incidence of post-traumatic stress, tunnel vision and gaps in memory (Blum, 1994).

  Various studies indicate an association between psychological factors and the occurrence of WRMSIs (Andersson, 1999; Devereux *et al.*, 1999; Davis and Heaney, 2000). Davis and Heaney (2000) found that biomechanical demands had a greater effect on individuals with low back pain who work in or under poor psychosocial work environments.

- ***Smoking***

  Smoking has been implicated as a risk factor for low back pain because it results in intervertebral disc vascular compromise and decreased bone mineral content which may result in increased susceptibility to fractures and other spinal injuries. Research has shown that emergency rescue personnel have higher occupational stress and anxiety, hence are more likely to smoke (Boshuizen *et al*., 1992; Palmer *et al*., 2003).

- ***Preventative measures***

  Primary WRMSI countermeasures, including adequate warm-up and strengthening exercises, correct use of protective equipment, good nutrition, proper hydration, correct lifting techniques as well as awareness of environmental conditions, can prevent an injury from occurring (McGrath and Ozanne-Smith, 1997; Maughan, 2000; Gieck, 2004; Twizere, 2004). Education of these preventative measures is essential to firefighters to safeguard themselves against injury.

WRMSIs can interfere with the ability of firefighters to carry out their duties by affecting their level of performance and result in increased absenteeism (Cromie *et al*., 2004). Persistence of chronic injuries or complications of injuries can result in firefighters being assigned to light duty resulting in other firefighters having to do the work of the injured firefighters (George, 2007; Mchunu, 2008). This puts greater occupational stress on the substitute firefighters resulting in the possibility of an increased risk for injuries. Furthermore, based on the impact of the severity of their injuries on their performance, firefighters may find the need to consider alternative employment (Bateman, 2007; George, 2008).

However, there appears to be no South African literature relating to the epidemiology and impact of occupational WRMSIs in the fire service, highlighting the need for investigation.

Therefore, investigation into the prevalence of WRMSIs and highlighting risk factors involved can be influential in decreasing the impact of these injuries.

1.3. AIM OF THE STUDY

The aim of this study was to identify the prevalence and risk factors for WRMSIs specific to firefighters in the Durban Metropolitan Fire Department.

1.4. OBJECTIVES AND HYPOTHESES

1.4.1. The first objective was to determine the demographic data of the firefighters.

1.4.2. The second objective was to determine whether demographic data was associated with the prevalence of WRMSIs among firefighters.

1.4.2.1. **Null Hypothesis One**: There is no significant relationship between demographic data and the prevalence of WRMSIs.

1.4.3. The third objective was to determine the prevalence and history of WRMSIs in the firefighters of the Durban Metropolitan Fire Department.

1.4.4. The fourth objective was to determine whether selected factors were associated with the prevalence of WRMSIs.

1.4.4.1. **Null Hypothesis Two:** There is no significant relationship between selected factors and the prevalence of WRMSIs.

1.4.5. The fifth objective was to assess the strength of the relationships of selected factors with the most common injuries presented in the results.

1.4.6. The sixth objective was to recommend preventative measures based on the results and the reviewed literature.

1.5. LIMITATIONS OF THE STUDY

Various methodological factors may contribute to inconsistent results when investigating the relationship between risk factors and injuries. According to Davis and Heaney (2000), these include timing of measurement of exposure and outcome (exposure and outcome) and reliability and validity of exposure measures. These methodological concerns are considered a limitation to this study as all cross-sectional studies are susceptible to selection effect where workers with injuries may choose less stressful or less demanding jobs. This can lead to an underestimation of the effect of the exposure on the outcome. This could be the circumstances of firefighters as firefighters with injuries generally move on to light duty. This study did not take into account that firefighters could have sustained WRMSIs due to organic pathology, infection or genetic conditions. Therefore, past medical history was not incorporated into the study.

Additionally, the effect of “memory decay” as proposed by Mouton (2002) may also contribute to an underestimation of the results as firefighters may not recall all injuries sustained during the period of prevalence in this study.

It was assumed that the firefighters from the Durban Metropolitan Fire Department would be willing to participate in the study by honestly completing the questionnaire used to collect data. This assumption was based on the approval of the Chief of the Fire Department of this study in the form of a Letter of Permission to conduct the study (Appendix B).

1.6. SIGNIFICANCE OF THE STUDY

1) Although there is extensive literature supporting a significant relationship between WRMSIs and occupational risk factors (Reichelt and Conrad, 1995; Nuwayhid *et al.,* 1993; Guidotti, 1998), an exhaustive literature survey revealed that no recorded studies have explored the association between work-related lifestyle and psychosocial factors and WRMSIs in firefighters. This study will therefore investigate these risk factors specific to firefighters.

2) The deficit of medical research on work-related musculoskeletal disorders, especially in South Africa, has resulted in the lack of awareness amongst health care professionals, including chiropractors, of high risk working environments (Rempel *et al.*, 1992). This study could be useful in identifying the extent to which the firefighting population is affected by these conditions.

3) According to Fayer and Williamson (1998), accurate and reliable occupational injury data are the essential starting point for the development of injury prevention programs. The results of this study could assist the management of the Durban Metropolitan Fire Department in formulating improved strategies to address health and safety concerns for firefighters. The secondary outcomes of this study could include decreased absenteeism and improvement of injury prevention strategies which in turn can translate into increased financial benefits to the Department.

4) Firefighters play a vital role in maintaining public safety. Working with a WRMSI can significantly affect the ability of firefighters to carry out their duties, thereby impacting negatively on the victims of fire (Cromie *et al*., 2004). Therefore, understanding and recognizing the cause and risk factors for injury can assist firefighters in effectively carrying out their duty to the public.

1.7. CONCLUSION

In this chapter, a synopsis of the background of the study as well as a motivation for the study was provided. The next chapter will present a theoretical discussion of reviewed literature with reference to the main issues in connection with the current study. These include WRMSI prevalence, mechanisms of injury, as well as a review of the factors being investigated in the study.

Chapter Three focuses on the design of this study, which employed a cross-sectional, retrospective study design. Details regarding the study population, sample size and sampling method are discussed. An in-depth description of the data collection methods is concisely presented. This includes tools used in data collection, issues of validity and reliability and the data collection procedures. The chapter concludes by describing the data analysis employed and by highlighting the ethical issues considered during the research process.

Chapter Four presents the statistical results and together with the discussion of their comparison with the literature as well as the acceptance or rejection of the hypotheses suggested in this study. Chapter Four concludes by proposing recommendations to the Fire Department based on the results of this study and the reviewed literature, as well as recommendations for future studies relating to this topic.

CHAPTER TWO: LITERATURE REVIEW

2.1. INTRODUCTION

This chapter begins by describing the occupation and work environment of a firefighter. The occupation is discussed in detail to illustrate the dangerous and demanding conditions firefighters encounter and hence their increased risk of WRMSIs. The prevalence and mechanisms of injuries sustained by firefighters are also discussed, followed by reviews the literature concerning occupational risk factors that have been suggested to play a role in the cause of WRMSIs as well as review of literature regarding injury prevention.

2.2. THE FIREFIGHTERS OCCUPATION

As a result of the increased risk of firefighters becoming disabled by the age of forty five, firefighting is regarded as the most dangerous profession in the United States (Ornberg, 1982; Karter and LeBlanc, 1994 and Reichelt and Conrad, 1995). Thus firefighting has been considered one of the worlds most honored but hazardous occupations where individuals are exposed to a high level of personal stress and danger (Ottlinger, 1997).

Firefighting primarily requires skills in preventing, combating and extinguishing fires (IFSTA, 1998). A firefighter must be an individual who has the necessary skill to correctly operate and maintain fire equipment as well as exercise good judgment during critical emergency situations (Conrad *et al.,* 1994). An exceptional level of physical fitness is required to withstand the activities of firefighting and overhaul as firefighting is the most physically demanding all professions (IFSTA, 1998). To be accepted into the fire service, applicants have to pass rigorous medical evaluations, meet stringent fitness standards and pass extensive psychological screening (Louhevaara, 1984; Sykes, 1993; Donovan and McConnell, 1998; Bateman, 2007). The following profile of the chain of command in

the firefighter occupation will be discussed in order to illustrate the uniqueness of the functions and duties of each sector.

2.2.1. LEADING FIREFIGHTER

These firefighters form the majority of the fire service staff. Their duties include (Oosthuizen, 2004; Bateman, 2007; George, 2008):

- Activities of firefighting (operating hoses and extinguishers, climbing ladders, extrication and overhaul).
- Rescue – rescue from vehicles, collapse, water, confined space, animal rescue and high-angle rescue. These firefighters also respond to emergencies involving hazardous materials and provide emergency medical care services to the public. Additionally, in times of flood these firefighters assist in removal of flood water as well as recovery of people, bodies and vehicles.
- Station activities – these include maintenance of vehicles and firefighting equipment, control room monitoring and administrative tasks including compilation of incident reports. Fitness training is also done at the station.

2.2.2. STATION OFFICER

The duties of a station officer include (Oosthuizen, 2004; Bateman, 2007; George, 2008):

- Application and implementation of fire legislation in order to prevent fire by evaluating and inspecting new building plans.
- Determination of the causes of fires.
- Public education on fire prevention and evacuation.
- Intermittently, station officers perform operational duties at fire scenes playing their part more prominently in incident command and providing information to superiors.

2.2.3. DIVISIONAL COMMANDER

The Divisional Commander is responsible for all activities of fire, hazardous materials, rescue, and emergency medical services. These tasks include (Oosthuizen, 2004; Bateman, 2007; George, 2008):

- Administrative management including dispatching of firefighters to various fire calls, scheduling vehicle usage and management of shift activities.
- On the fireground – delegation of tasks to firefighters and are involved in incident command.
- Overseeing all activities of firefighters and addressing their grievances.

2.2.4. REGIONAL COMMANDER

The Regional Commander performs similar duties of the Divisional Commander but in a specific region. These firefighters therefore oversee the various divisions in a specific region (Oosthuizen, 2004; Bateman, 2007; George, 2008).

2.2.5. FIRE CHIEF/DEPUTY CHIEF

The Fire Chief assumes the highest position in the chain of command. All firefighters report indirectly to the Fire Chief in the chain of command. This occurs through the principle of *unity of command* in which a person can only report to one supervisor. In this way, each subordinate reports to one boss. This moves throughout the chain of command to ultimately reach the Fire Chief (IFSTA, 1998; Oosthuizen, 2004; Bateman, 2007; George, 2008).

2.3. THE CONTEXT OF THE FIREFIGHTER OCCUPATION

Firefighters respond daily to alarms without any prior knowledge of the nature of the emergency. The public hope that when there is a plea for help, these professionals will respond and come to their aid. The emergency is commonly the result of carelessness and/or human error resulting in firefighters routinely putting their lives at risk (Rose, 1996).

In terms of the fireground, this is usually filled with toxic gases and blinding smoke where firefighters are required to extinguish the fire and rescue victims who may or may not be conscious or ambulatory.

Figure 2.1. The fireground

(Picture extracted from Fahy, R.F., LeBlanc, P. and Molis, J.L. 2008. *2007 Firefighter Fatalites*. (online) Available from http://www.iaff.org/08News/PDF/NFPAReport.pdf.

In order to address the above situations all firefighters have to wear PPE commonly called “turn out gear.” An auxiliary fixture to the turn out gear is

a SCBA which is designed to provide oxygen to firefighters while working in environments with dangerous conditions or toxic exposure. This is carried in a harness on the firefighters back. The depletion of the oxygen in the cylinder depends on the size of the container, the effort the firefighter exerts and his level of physical fitness (Louhevaara, 1984; Sykes, 1993; Donovan and McConnell, 1998; Hooper *et al.,* 2001). Together, the protective gear and the SCBA weigh approximately 20-25kg (Louhevaara, 1984; Gilman and Davis, 1993).

Figure 2.2 Protective gear worn by firefighters, called "turn out" gear (Picture by Albert, 2008)[2]

[2] ***Permission granted (Appendix B)***

Figure 2.3. A Self-Contained Breathing Apparatus (Picture by Albert, 2008)[3]

Many studies have ascertained that the workload of a firefighter uses up to 60-80% of maximal oxygen consumption and up 95% of maximum heart rate (Lemon and Hermiston, 1977; Manning and Griggs, 1983; Sothmann *et al.*, 1992). This physically demanding profile is not only due to the environmental stressors faced, but also due to cumbersome equipment, most significantly, the SCBA (Cady and Thomas, 1985).

Firefighters have to be agile, crawling through narrow spaces and in awkward positions; climbing ropes and ladders; and pulling heavy, charged hoses. They run the risk of falling through roofs and floors or being in a room where the walls and ceiling may collapse (Reichelt and

[3] ***Permission granted (Appendix B)***

Conrad, 1995; Rose, 1996). Furthermore, during extrication, firefighters have to operate heavy cutting equipment and break through doors, roofs or floors. All of this has to be tackled while carrying the burden of their heavy and bulky protective clothing, helmet and SCBA (IFSTA, 1998).

Once the fire is extinguished and the area is clear, the work, however, does not end as the firefighters have to continue with overhaul. The overhaul environments are not safe, despite the primary fire having been extinguished. The area is slippery, and structures are falling apart. Firefighters run the risk of slips, falls or being struck by falling objects. It is tedious work, and the firefighters are already exhausted from fire suppression (Rose, 1996; Guidotti, 1998). In addition to fires, emergencies can include cave-ins, building collapses, aircraft crashes, hazardous materials incidents, motor vehicle accidents, rescue operations, water incidents and medical emergencies (IFSTA, 1998).

Due to this unique, complex and dynamic work environment, the risk of injury and death are exceptionally high (Nuwayhid *et al.,* 1993; Reichelt and Conrad, 1995; Guidotti, 1998). This increased risk of injury can be seen in a study by Reichelt and Conrad (1995), where WRMSIs have been found to account for almost half of all line- of –duty injuries among the one million firefighters in America. These injuries were primarily sprains, strains and muscular pain largely affecting the lower back.

Therefore, the occupational requirements of firefighting are stringent and firefighters have to continuously focus on the preventative measures to maintain their own health and safety.

2.4. INCIDENCE AND PREVALENCE OF WRMSIs

The Health and Safety Executive of the United Kingdom (2008) describes WRMSIs as the most common occupational problem facing Great Britain and account for at least one-third of all work-related injuries in the United States (Dong-Chui and Blair, 2003).

WRMSIs commonly affect the back, cervical spine and upper extremities (Andersson, 1981; Putz-Anderson, 1992; Stobbe, 1996). Bigos *et al.* (1991) describe low back injuries as the most costly healthcare problem facing industrialized nations. The World Health Organization (2003) as cited by Ehrlich (2003) has described occupational low back pain as an epidemic that can only be controlled by multidisciplinary management, including chiropractic.

A number of surveys of self-reported work-related illnesses have been carried out by the Health and Safety Executive (2008) in the period of 2004/5 in Great Britain that reflected 11.6 million working days were lost through WRMSIs caused by or made worse by work. On average, each person affected by occupational WRMSIs took an estimated 20.5 days off from work in the 12 month period. In addition, the study found that 45% of these injuries mainly affect the low back- which alone accounted for an estimated 4.5 million working days lost in the 12 month period. Furthermore, a total of 18% of the reported findings affected the lower limbs. On average, each affected person took an estimated 17.4 days off from work in the 12 month period. A total of 18% of the reported findings affected the lower limbs.

WRMSIs are the most common work-related injuries among firefighters (Conrad *et al.,* 1994; Reichelt and Conrad, 1995; Karter and Molis, 2004; Karter and Molis, 2006; Karter and Molis, 2007). The National Fire Protection Association in the US (1999) analyzed fire ground injuries in the period of 1993-1997 and found that sprains, strains and muscular pain

accounted for the highest percentage of the most severe injuries. In 2001, sprains, strains and muscular pain again accounted for 47% of overall injuries with strain and overexertion accounting for 33% of these injuries. This figure decreased to 32.4% in 2003 (Karter and Molis, 2004), increased to 44.4% in 2005 (Karter and Molis, 2006) and further increased to 46.7% in 2006 (Karter and Molis, 2007).

In the United States, work-related WRMSIs cost employers around US$15 to US$18 billion a year in workers' compensation, as well as further substantial losses through absenteeism and decreased productivity (Dong-Chui and Blair, 2003).

Thus, as WRMSIs are the primary cause of absenteeism and disability in the fire service, they are of increasing concern to employers, workers, insurance carriers, regulatory bodies and occupational health therapists (Reichelt and Conrad, 1995).

2.5 TYPES OF WRMSIs

WRMSIs can be divided into two categories- overuse injuries and overexertion injuries.

2.5.1. OVERUSE INJURIES

As the term suggests, overuse injuries are the result of using the tissues continuously or for long periods resulting in the body being unable to keep up with repair to the damaged tissue (Putz-Anderson, 1992). Clinical presentation may take hours, days, months or even years as repeated small injuries build up over time (Putz-Anderson, 1992; Stobbe, 1996). Some work tasks that are associated with these injuries include gripping, reaching, bending and twisting. These tasks, when performed in moderation are no more hazardous than similar activities performed during daily activities. It is the combination of endless repetition, use of forceful

exertions, awkward body position and insufficient rest period for the affected body parts that make these activities hazardous (Putz-Anderson, 1992; Stobbe, 1996; Keyserling, 2000). These injuries can occur during firefighting when handling cutting equipment, during extrication and handling hoses (Reichelt and Conrad, 1995).

2.5.2. OVEREXERTION INJURIES

Overexertion injuries involve the muscles, tendons and ligaments and occur when they are subjected to a single traumatic event that exceeds their strength or range of motion (Putz-Anderson, 1992; Stobbe, 1996; Keyserling, 2000). They usually occur during lifting, pushing or pulling objects and can result in a sprain, strain or tear injury (Stobbe, 1996; West and Gardner, 2001). Repetitive force can result in stress or fatigue fractures while increased force can result in high energy fractures and dislocations e.g. fall from a height (Haslett *et al.,* 2002).

The Health and Safety Executive (2008) describe in their International Hazard Datasheets on Occupation some activities during firefighting that increase the risk of overexertion WRMSIs. These include injuries from falls from heights or due to collapsing structures (fractures, dislocations, muscle contusions), during ladder work (strains and crush injuries), being struck by falling objects (muscle contusions and fractures) during rescue or salvage (sprains, strains, tendonitis, ligamentous injury) and overexertion while lifting objects/equipment/casualties (disc injury, muscular strain, ligamentous injury and injury to the vertebral column and associated nerves).

2.6. AREA AND MECHANISM OF WRMSIs IN FIREFIGHTERS

Low back injuries are the most common injuries among firefighters and have resulted in the focus of previous studies being primarily focused on evaluating the risk factors associated with firefighting and injuries to the low back (Nuwayhid *et al.*, 1993; Reichelt and Conrad, 1995; Guidotti, 1998). According to Levy and Wegman (2000), low back pain is one of the oldest and most common occupational health problems in history. Levy and Wegman (2000) further cite Ramazzini, commonly called the "founder" of occupational medicine, who in 1713 observed that certain violent and irregular motions and unnatural postures of the body resulted in impairment of the internal structure. Incorrect postures during lifting of objects are one of the most common causes of low back injuries.

Figure 2.4. Incorrect lifting postures

*(*Picture by WorksafeBC. 2006)

The United States Fire Administration (1996) found that firefighters often complain of back pain due to the constant twisting, pushing, pulling, lifting

and bending involved in the occupation, resulting in growing concern that firefighters with pre-existing back conditions can sustain severe injuries due to the demands of their occupation.

Nuwayhid *et al.* (1993) described some high and low risk activities for back injuries in firefighters. The high risk activities include operating charged hoses, breaking windows, cutting structures, climbing ladders and lifting objects more than 18kg. Whereas low risk activities included pulling booster hoses, participating in fire drill or physical training and connecting pumpers to hydrants. These activities can result in sprain and strain injuries, muscle and ligamentous tears as well as disc injuries.

Further to above study, Reichelt and Conrad (1995) describe some workplace risk factors for back injuries that have been have also been found to be associated with back pain in other industries (physical therapists, nurses and truck drivers). These include, but may not be limited to, lifting heavy objects (West and Gardner, 2001), work postures (Glover *et al*., 2005), stretching and reaching (Tim, 1996 and Pope *et al*., 1991), sudden maximal effort (Holder *et al*., 1999), heavy manual labor, cumulative load exposure (Cromie *et al.,* 2000), working more than 40 hours a week (Rupert and Ebete, 2004), safety training and vibration during driving e.g. fire trucks driving at high speeds (Ramroop *et al*., 2006).

While back injuries have been determined to be the most common area of injury among firefighters, other anatomical areas are also vulnerable. Marriot and Lillicrap (1994) assessed the firefighter injuries in the United Kingdom from 1986-1990 and found that the most frequently affected areas besides the low back, included the limbs (knees and ankles) and the arms. Furthermore, 50% of the total injuries sustained were sprains and strains followed by fractures representing 10%.

In 1999, a Swedish study analyzed the injuries sustained by 111 firefighters and determined that 51% of WRMSIs occurred during fitness training. In the study, 82% of the firefighter sustained injuries during soccer and floorball which was played during fitness training, 51% of which were meniscal and sprain injuries to the knees or ankles (Bylund, and Ornstig, 1999).

Awkward work postures can also cause injuries when a joint moves farther towards either its end range of motion or from neutral posture. According to Zenz (1998), work posture should make it possible to retain the joints in mainly neutral positions, i.e. neither heavily flexed nor extended. Work postures in which the trunk is twisted or bent or in a way that the joints are forced to function at their extreme positions, frequently give rise to musculoskeletal complaints. There is a direct proportional relationship with awkward posture and the strain on muscles, tendons and ligaments around the joint. For example, when arms are fully stretched out, the elbow joints are at the end of their range of motion. If the firefighter pulls or lifts repeatedly in this position, there is a higher risk of injury (Conrad *et al.,* 1994). Figure 2.1 below illustrate some awkward working postures.

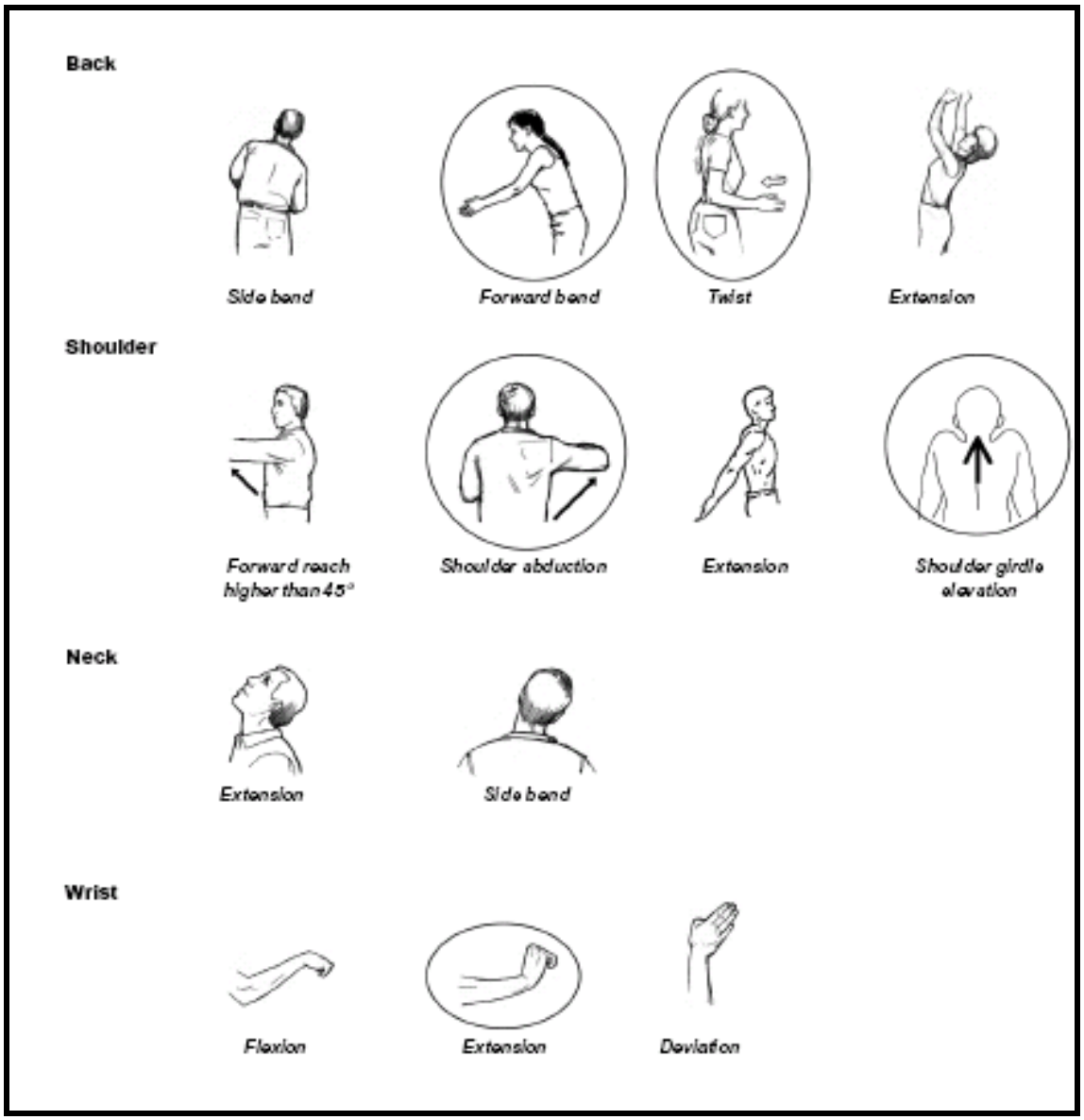

Figure 2.5 Awkward working postures

(Picture by WorksafeBC. 2006)

While these postures are harmless when performed once in a while, working for prolonged periods in these positions can cause a WRMSI (Keyserling, 2000; Quinn, 2008).

Another mechanism of injury could be related to the study of Theorell *et al.* (1993) who hypothesized that long-term elevated levels of cortisol may make muscles more vulnerable to mechanical loads. This does raise the possibility that the excess or deficiency of other chemicals in the muscles

and nerves may lead to the same effect. Firefighters are exposed to a myriad of chemicals and toxic smoke. The effects of cigarette smoking and it effects on the muscles has been well documented (Boshuizen *et al.,* 1992; Leino-Arjas, 1998; Palmer *et al.*, 2003).It is thus plausible that exposure to toxic smoke during firefighting may effect the musculoskeletal system.

The prevalence of WRMSIs in the fire service is substantial (Conrad *et al.,* 1994; Reichelt and Conrad, 1995; Karter and Molis, 2004; Karter and Molis, 2006; Karter and Molis, 2007). However, the focus of research has purely been on the factors affecting the low back (Nuwayhid *et al.,* 1993; Reichelt and Conrad, 1995; Guidotti, 1998). In addition, the nature of injuries has been investigated only as sprains, strains and muscular pain. This study is designed to be comprehensive by incorporating WRMSIs that affect all areas of the body and the various natures of WRMSIs. Furthermore, this study investigated risk factors for WRMSIs in firefighters that have not previously been considered.

2.7. RISK FACTORS INFLUENCING WRMSIS

2.7.1 HEIGHT

A study by Jayson (1996) established that individuals with an above average height (greater than 1.74m) have a greater propensity for developing low back pain than those of shorter stature. The study determined that the reason for this was twofold. First was the tendency of taller individuals to stoop to appear shorter. Additionally, height also increases the weight and consequently, the force needed to support the lower spine with movement. The results of this study were consistent with that of other reviewed studies (Gytelberg, 1974; Roncarati and McMullen, 1988; Alcouffe *et al.,* 1999 and Mortimer *et al.,* 2001).

2.7.2 WEIGHT

Silverstein *et al.* (1987) suggested that there was a relationship between obesity and disorders of the wrist and hand, especially carpel tunnel syndrome. Carpel tunnel syndrome occurs due to inflamed tendon sheaths of the carpal tunnel in the wrist resulting in impingement of the median nerve (Haslett *et al.,* 2002). This results in pain, numbness and tingling of the thumb and fingers, which eventually leads to difficulty in grasping and holding objects. This can also result in the predisposition to other injuries such as falls from ladders due to poor grip and strain injuries when carrying casualties and equipment.

According to Jayson (1996), people who are overweight are at greater risk for the development of low back pain, joint pain and muscular strain than those who are not overweight. This is supported by the American Obesity Association (2008) which states that patients who carry more weight on their midsection are at greater risk for obesity related health problems, including low back pain.

A recent study by Pollack *et al.* (2008), found that the odds of injury were greater for obese workers compared to their leaner counterparts. Injuries to the knee and leg were the most prevalent over the two year period evaluated in the study. The study concluded that there is a significant association between increased body mass index (BMI) and traumatic workplace injuries.

2.7.3 PROTECTIVE GEAR

The Oregon Occupational Safety and Health Association (OOSHA) (2007) describe Personal Protective Equipment (PPE) as a barrier between the worker and the hazard source. The Association reports that although these devices may decrease the duration, frequency or intensity of exposure, the effectiveness of PPE injury reduction is inconclusive. This

maybe due to PPE being effective in one instance, to reduce exposure, whereas it may increase the susceptibility to injury as the worker has to "fight" the device to perform his/her work.

While the use of the breathing apparatus and protective gear helps reduce exposure, there is trade off between protection against chemical hazard and the creation of an impractical mechanical load. In addition to being heavy, the protective gear is bulky, traps body heat and most importantly, restricts movement, resulting in an increased risk of injury as firefighters have to strain themselves to perform activities they otherwise perform with ease (Rose, 1996).

Trapped body heat in a superheated firefighting environment can cause heat exhaustion, muscle cramps, dehydration, electrolyte imbalance and loss of mental/physical work capacity (Beers, 2004). Profuse sweating can result in reduce blood volume making the muscular system compete more vigorously for blood flow predisposing a firefighter to muscle cramping and possible injury (Queensland Fire and Rescue Service, 2007).

Due to it's impediment to the musculoskeletal system based on its weight and design, it is plausible that firefighter PPE could predispose firefighters to WRMSIs.

2.7.4 FITNESS

From the sound of the fire alarm to the end of overhaul, the firefighter must go from a resting state to maximum physical effort (Davis and Dotson, 1991). The Queensland Fire and Rescue Service (QFRS) (2007), state that physical fitness plays a major role in the body's ability to handle stresses in a hot and humid environment, as enormous stress is placed on the cardiorespiratory system. This can prove life-threatening in times of high work demands in a very hot environment.

As previously discussed, firefighters face a potentially dangerous combination of stresses: heat, high body temperature and risk of dehydration (Louhevaara, 1984; Shearer, 1989). This produces a physiological response that results in adrenaline release which in turn causes increased heart rate, blood pressure, respiratory rate as well as increased muscle tension (Beers, 2004).

Studies assessing the physical stress associated with the fire PPE and the SCBA have shown significant increases in heart rate, oxygen consumption and respiratory rate, as compared to exercising without equipment (Louhevaara, 1984; Sykes, 1993; Love *et al.*, 1994; Donovan and McConnell, 1998). Louhevaara (1984) has identified four parameters affecting physical work performance with the use of SCBA: additional breathing resistance; external dead space; added weight of the apparatus and fitness of the individual.

However, physically fit individuals can adapt to increased biomechanical loads, resulting in decreased susceptibility to injury (Louhevaara, 1984; Sothemann *et al.*, 1992; Lusa, 1994).

Despite these findings, thirty three percent of fire fighters in the US were measured as obese with this figure increasing to 40% within four years (Rodgers, 2007) and have been reported to have a lower physical fitness level than those of other hazardous occupations, including construction workers and policemen (Barnard, 1979).

Fatigue is often the cause of injury as it results in the muscles and tendons not contracting in a sequential manner, resulting in injury in the form of a sprain, strain or fracture (Gieck, 2004; McGrath and Ozanne-Smith, 1997). The National Strength and Conditioning Association in the US thus recommend strength and flexibility training to develop musculoskeletal strength, endurance and functional movement around joints for health fitness and injury prevention (Roger *et al.,* 2004). A warm up session

should precede physical activity to avoid injury (Gieck, 2004; Prentice, 1999; McGrath and Ozanne-Smith, 1997). This is especially significant as firefighters sometimes have to go from a resting state to maximal physical effort.

Improved physical functioning enables one to perform tasks with less physiological stress, while weight training causes mechanical loading of the skeleton via gravitational forces or forces produced by muscular contraction will influence bone mass (decreases the risk of osteoporosis, hence reducing the chances of fractures and bone degeneration (Turner, 1998; Turner and Robling, 2003). In addition, improved flexibility can be significant in reducing low back injuries as lack of flexibility from decreased activity or poor posture increases the risk of chronic low back pain (Roger *et al.,* 2004).

2.7.5 STRESS

Stress is recognized as one of the most serious occupational hazards in the fire service that can affect health, well being and the career of a firefighter (Hildebrand, 1984). This has resulted in the United States Fire Administration (1996) advising the importance of recognizing how stress can adversely affect health, decision making and job performance. Moreover, psychological stress is one of the foremost causes of psychiatric, drug and alcohol problems. Higher divorce rates and lower marital adjustment among firefighters has also been attributed to job-related stress (Hildebrand, 1984, Blum, 1994).

Hildebrand (1984) has identified five psychosocial stressors that are unique to the fire service:

- ***Level of certainty*** – most occupations have a level of certainty of what to expect at work. However, fire personnel do not know what new challenges the day will

bring and have little control over these unpredictable events.

- ***Physical response to an alarm*** – When there is a call for help at the fire station, the firefighter's body prepares itself for increased physical demands. In the absence of a fire or emergency, the increased adrenaline, levels of blood pressure, blood sugar and muscle tension remain and may take several hours to stabilize to normal levels (Marmar *et al.*, 1996).

- ***Interpersonal tension*** – the critical nature of firefighting has the propensity to amplify tensions between people. These tensions would be far less in a non-firefighting environment. While poor communication, lack of coordinated effort and faulty equipment may be a serious transgression in an office, this can be detrimental or fatal on the fire ground.

- ***Exposure to human tragedy*** – while the fire service takes pride in being heroic and "running into buildings that everyone else runs out of," the price for that pride is being on hand when people lose their families, homes and businesses.

- ***Fear***- Like most people, firefighters do not often express their fears. Despite their composed demeanor, firefighters have valid concerns for their own safety, that of their co-workers and the consequences of a possible mistake on the people around them.

In 1980, Post-traumatic Stress Disorder (PTSD) was recognized as a bona fide diagnosis after a large number of Vietnam veterans began to exhibit common

symptoms diagnostic of the disorder. PTSD is distinguished as a long-standing and pervasive disorder caused by exposure to human tragedy. The fundamental feature of PTSD is the development of characteristic symptoms following the experience of a traumatic event that is "outside the range of normal human experience" (Ottlinger, 1997). Firefighters witness repeated traumatic events in their line of work and therefore are susceptible to post-traumatic stress (Blum, 1994; Shantz, 2002).

A study by Devereux *et al.* (2004) showed that work-related stress and musculoskeletal disorders was the leading occupational health problem in the European Union. The Oregon Occupational Health and Safety Association (2007) suggest the following four explanations to account for the association between work-related psychosocial factors and WRMSIs:

- Psychosocial demands may produce increased muscle tension and exacerbate task-related biomechanical strain.
- Psychosocial demands may affect awareness and reporting of musculoskeletal symptoms, and/or perceptions of their cause.
- Initial episodes of pain based on a physical insult may trigger a chronic nervous system dysfunction, physiological as well as psychological, which perpetuates a chronic process.
- In some work situations, changes in psychosocial demands may be associated with changes in physical demands and biomechanical stresses, and thus associations between psychosocial demands and musculoskeletal disorders occur through either a causal or effect-modifying relationship.

The above explanations are consistent with a number of studies which have investigated the association between psychological factors and the occurrence of WRMSIs, especially to the low back (Burton, 1997; Andersson, 1999; Kirkaldy-Willis and Bernard, 1999; Devereux *et al.,* 1999; Davis and Heaney, 2000).

Delsohn (1996) describes how the public's expectation of bravery from firefighters results in denial and containment of stress which Marmar *et al.* (1996) attributes to trauma related dissociation. Therefore, a firefighter's perception of their stress is not an accurate measurement.

Repeated stressful encounters or sometimes a single event, can cause the body to react chronically as if in an emergency situation in the absence of emergency e.g. chronically elevated blood pressure in the absence of evidence of circulatory defects, chronic gastrointestinal distress (e.g. ulcers, heartburn), abrupt change in mood (e.g. hypervigilance, agitation, social withdrawal and poor concentration), multiple awakenings (e.g. nightmares, fear, hallucinations), migraines, inappropriate emotion reactions to situations, inability to defuse after a call is cleared, "high risk" behavior and psychophysiological distress (Marmar *et al.*, 1996; Haslett *et al.,* 2002). Therefore, this study used the prevalence of stress-related symptoms and illnesses as a measurement of stress in firefighters.

Firefighters have also acknowledged the continuing experience of musculoskeletal pain, discomfort and stiffness in the absence of any physical trauma or injury, which has been attributed to the effect of adrenaline, which are released due to stress. Adrenaline increases skeletal muscle tension, which is necessary for readiness in combat. Ammonia and lactic acid (Hydrogen ions)- wastes of muscle activity- build up with increased activity which results in further soreness and physical fatigue which is seen in prolonged stress (Blum, 1994). This could also be accredited to psychosocial factors influencing various chemical reactions in the body which take place during job tasks. It has been hypothesized that increased muscle tension associated with poor psychosocial factors may reduce blood flow, resulting in the accumulation of metabolites and resultant pain (Backus and Dudley, 1974).

Knee injuries are also one of the common sites of WRMSIs among firefighters. It is proposed that regular lifting of heavy objects may predispose the joint to injury (Marriot and Lillicrap, 1994). Additionally, a 2006 study by Jones *et al.* (2007) suggests that psychosocial factors, along with mechanical loading, are risk

factors for the onset of knee pain. In this prospective cohort study, Jones *et al.* (2007) sampled 859 newly employed workers from various occupational settings who were free of knee pain. These employees were examined after 12 and 24 months. They completed questionnaires regarding occupational mechanical factors and psychological and psychosocial factors. During the 2-year follow-up, there were 108 cases of new onset knee pain. Mechanical load, postural factors, psychological distress, and workplace psychosocial factors were risk factors for new onset knee pain during the 2-year follow-up period. The use of multivariable analysis revealed that 2 factors independently predicted knee pain onset: lifting or carrying heavy weights in one hand and the level of general psychological distress.

Alcoholism is frequently associated with stress and depression (Dixit and Crum, 2000; Caldwell *et al.,* 2002; Graham *et al.,* 2007). Skeletal muscle myopathy attributed to alcoholism occurs in between one third and two thirds of all chronic alcohol abusers, and is a major cause of morbidity (Martin, 1985; Urbano-Marquez *et al.,* 1989). Alcoholic myopathy is characterized by a reduction in skeletal muscle protein synthesis, total RNA and protein content and the myofibrillary protein contents (Slavin *et al.,* 1983; Preedy and Peters, 1988; Reilly *et al.,* 2000). Urbano Marquez *et al*. (1989) found that heavy alcohol consumption damages the heart muscle in one third of the subjects, and skeletal muscles in half of them. In addition, muscle weakness is proportional to the amount of alcohol consumed; however, this myopathy is reversible if alcohol consumption stops (Slavin *et al.,* 1983).

Therefore, alcohol consumption has a negative effect on skeletal muscles (Slavin *et al.,* 1983; Hakahara *et al.,* 2003). It is therefore plausible that increased alcohol consumption can predispose individuals to WRMSIs.

2.7.6. SMOKING

Another associated habit of anxiety, stress and depression is smoking. Smoking has been linked to the incidence of WRMSIs (Boshuizen *et al.,* 1992; Palmer *et*

al., 2003) and increased use in firefighters (Schuster *et al.,* 2001; Heldering, 2004).

Studies have indicated that there is a link between smoking and general injuries as well as disorders of the neck, shoulders and back (Boshuizen *et al.,* 1992; Leino-Arjas, 1998; Palmer *et al.*, 2003). Furthermore, Palmer *et al.* (2003) and Leino-Arjas (1998) found that smokers, as well as ex-smokers, report more pain and musculoskeletal symptoms than non-smokers.

Cigarette smoking has been implicated as a risk factor for WRMSIs military training and athletic conditioning in several studies (Jones *et al.,* 1993; Jones *et al.,* 1994; Reynolds *et al.,* 1994; Knapnik *et al.,* 2001). Altarac *et al.* (2000) investigated the effects of smoking on exercise-related injury during army basic training. Recruits who reported smoking at least one cigarette during the month prior to basic training had significantly higher injury rates during training than those who did not smoke. Male smokers had a 12.9% injury rate compared to 7.2% in their non-smoker counterparts while female smokers had a 13.4% injury rate compared to the 11.8% injury rate in the female non-smokers. The strongest relationship associated with the history of smoking was overuse injuries which produced 1.5 times higher injury rate in smokers than non-smokers. The study thus concluded that the detrimental effects of smoking persist for several weeks after the cessation of smoking, as smoking was not allowed during basic training. In addition, smokers report a higher frequency of injuries and illness, are less physically active and have a lower level of physical fitness than non-smokers (Gardner, 2000).

Another effect of smoking is the poor blood circulation which is thought to be due to the effects of nicotine (Leino-Arjas, 1998; Quilter, 2000). The body relies on efficient blood circulation to supply oxygen and nutrients to the muscles, tendons and ligaments. Restricted blood circulation caused by nicotine results in poor waste removal, causing the accumulation of waste in soft tissues. Smoking also replaces oxygen with carbon monoxide, which is detrimental to healthy tissues. With the deficiency of oxygen and nutrients, the soft tissues tire easily, resulting in an increased risk of injury (Pascarelli and Quilter, 1994; Leino-Arjas, 1998;

Quilter, 2000). This is also evident in the findings of other studies (Silverstein, 1992; Gardner, 2000) in which smokers demonstrated poor wound healing from trauma injuries, surgery and disease.

A further effect of smoking is pathological changes in bone, resulting in osteoporosis (Gatterman, 1990; Campion and Maricic, 2003). Osteoporosis is a disease characterized by reduced bone mass and microarchitectural deterioration of bone tissue (Haslett *et al.,* 2002). Campion and Maricic (2003) describe the mechanism of the link between bone loss and smoking duration and quantity, as a combination of:

- Decreased body weight
- Decreased calcium absorption
- Decreased estradiol levels
- Direct toxic effect on bone metabolism.

The greatest concern with regards to osteoporosis is the increased risk fractures (Boshuizen *et al*., 1992; Haslett *et al.,* 2002; Palmer *et al.,* 2003). In view of the fact that reduced bone density does not cause symptoms, an osteoporotic individual may be completely asymptomatic until a fracture occurs (Haslett *et al.,* 2002). This may be produced with minimal trauma and, when it occurs in the back, is often accompanied by painful muscle spasm (Gatterman, 1990; Haslett *et al.,* 2002). These fractures may occur anywhere, but the most common sites include forearm, spine and femur (Haslett *et al.,* 2002).

In light of the above research, it is therefore plausible, that smoking interferes with the body's ability to repair muscle, bone and other tissue, leaving smokers more susceptible to injury.

2.8. INJURY PREVENTATION

The World Health Organization (1998) as cited by Ehrlich (2003) defines health promotion as the "process of enabling people to increase control over, and

improve health. To reach a state of physical, mental and social well-being, an individual or group must be able to identify and realize aspirations, to satisfy needs and to change or cope with the environment."

With this in mind, injury prevention has been determined to be more cost-effective than treating chronic injuries (Rodgers, 2007; OOSHA, 2007). McGrath and Ozanne-Smith (1997) and Brukner and Khan (2003) describe injury countermeasures as measures acting before an incident that could potentially lead to injury, to prevent the event from occurring in the first place. Primary measures for the prevention of WRMSIs include physical conditioning, proper protective equipment, adequate warm-up and strengthening exercises, good nutrition and hydration and the correct use and maintenance of equipment.

These factors are especially important to firefighters can burn between 5000-6000 calories a day (National Wildfire Coordinating Group (NWCG), 2004). It is important to replace these calories to prevent fatigue, cramping and judgment impairment. Proper rest and nutrition are essential for optimal performance (Gieck, 2004). Thus, nutritious food, with an increased carbohydrate intake can fuel the muscles for hard work (Gieck, 2004; Maughan, 2000). Furthermore, hydration is an important part of nutrition as dehydration of as little as 2% can affect physical performance, which can result in injury (Gieck, 2004). Water is an excellent for replacing fluid loss and natural juices contain energy-restoring glucose (NWCG, 2004).

The British Columbia Worker's Compensation Board (2006) provides the following tips for preventing low back injury:

- Bend at the knees, hold and lift the object
- Keep the object as close to you as possible (use a bear hug)
- Balance the load using both hands
- Minimize the distance reach when picking up an object
- Strengthen abdominal muscles

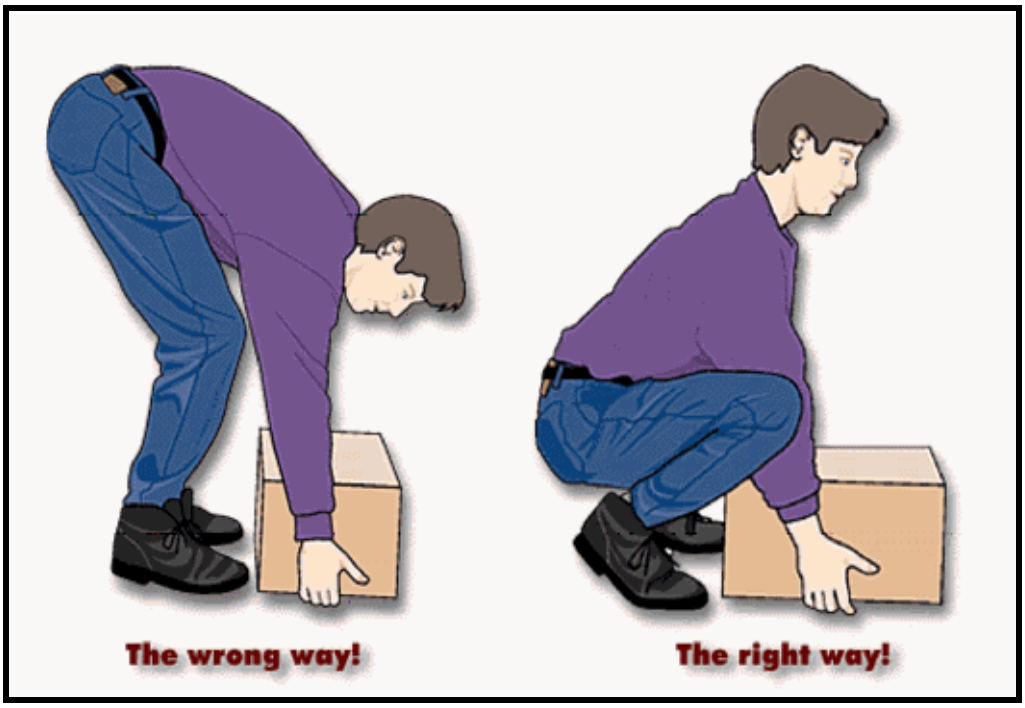

Figure 2.6 Correct lifting postures

(Picture by WorksafeBC. 2006)

As low back injuries is the most common area of injury in the fire service (Reichelt and Conrad, 1995; Guidotti, 1998), reiteration of these measures can significantly impact on the firefighters ability to protect his low back during work activities.

Smoking reduces lung capacity and narrows blood vessels, decreasing the amount of oxygen available during strenuous activities (NWCG, 2004). The effects of smoking on circulation and bone mass have already been discussed. Having good social support, behavioral counseling and a role model who has successfully quit smoking have been proven essential to quitting (Law and Tang, 1995).

2.9. CONCLUSION

The literature review and conversations with Department administrators as well as fire service professionals provide the basis for this study. The significance of WRMSIs in occupational health of firefighters has been presented in this chapter. The research process will now be discussed in Chapter Three.

CHAPTER THREE: METHODOLOGY

3.1. INTRODUCTION

This chapter focuses on the methods and instruments used to conduct the research as well as the statistical methodology employed. The topics to be addressed include the study design, sampling method, the research tool, ethical considerations and statistical methodology employed in this study.

3.2. STUDY DESIGN

A cross-sectional study design was chosen for this study. Cooper and Schindler (2001) and Lilenfield and Stolley (1994) describe a cross-sectional design as a time dimension study where information is obtained simultaneously on exposure from a selected sample of a population, the outcome of which is to determine whether persons with a particular exposure characteristic, are more likely to have the outcome (condition) being investigated. Furthermore, the study was a retrospective prevalence study, which was quantitative in nature with the outcome measured over a period prevalence of 3 years (Mechem *et al.*, 2000; Bateman, 2007).

Based on the above structure this research was approved by the Faculty of Health Sciences Research and Ethics Committee (Appendix H), indicating that the research complied with the principles enshrined in the Declaration of Belmont, Helsinki and Nuremberg (Johnson, 2005).

3.3. SAMPLING

A sample is a group of subjects selected from a larger group, in the hope that studying this smaller group will reveal important things about the larger group (Trochim, 2001).

3.3.1. SAMPLE SIZE

The first step in the sampling process was to obtain a list of all firefighters employed at the Durban Metropolitan Fire Department. There were 499 firefighters in the Durban Metropolitan Fire Department positioned at various stations but only 350 were actively firefighting (N=350) (Gloster, 2007). The response rate required prior to statistical analysis was defined as a minimum response rate of 28%, thus a sample of 100 (n=100) firefighters was required in order for the statistics of this study to be representative of the study population (Esterhuizen, 2007).

3.3.2. SAMPLING METHOD

Stratified random sampling with probability proportional to size was used to determine the sample size (n=100) (Esterhuizen, 2008). Stratified random sampling is a procedure which first categorizes a population into subgroups and then randomly selects from each subgroup until a desired number is reached. In this study, the population was stratified on site of fire station and the proportion of members at each site in the population was applied to the sample. Within each site random sampling was done. All 350 firefighters were invited to participate in the study and the above sampling was used to acquire representation from all the stations in the Durban Metropolitan Fire Department. This study was able to obtain large enough samples for each subgroup for statistical analysis (Trochim, 2001; Esterhuizen, 2008).

Station	No. of Firefighters	Proportion	PPS Sample size
Durban North	8	0.02	2
Phoenix	20	0.06	6
Ntuzuma	20	0.06	6
Umhlanga	20	0.06	6
Amanzimtoti	20	0.06	6
Umlazi	16	0.05	5
Prospecton	16	0.05	5
Mobeni	16	0.05	5
Pinetown	20	0.06	6
Central	64	0.18	18
Congella	8	0.02	2
Jacobs	32	0.09	9
Chatsworth	16	0.05	5
Tongaat	16	0.05	5
Pinetown South	6	0.02	2
Gilletts	16	0.05	5
Westville	16	0.05	5
Queensburgh	4	0.01	1
Hammersdale	16	0.05	5
Total	350	1	100
Sample size (minimum)	100		

Table 3.1. The firefighter distribution to each station from which sampling was carried out to achieve sample size (n-100).

3.4. SAMPLE CHARACTERISTICS

3.4.1. INCLUSION CRITERIA

In order to participate in this study, the firefighters at the Durban Metropolitan Fire Department had to comply with the following criteria:

1. Firefighters had to be either qualified or trainee firefighters, registered with the South African Emergency Service Institute (SAESI). This assured that the firefighters in the sample had professional training according to the standards of the SAESI.
2. Firefighters had to have been in service for a period of 3 years or more.
3. Firefighters had to be working in the firefighting field at the time of the study.

3.4.2. EXCLUSION CRITERIA

Firefighters were excluded from the study if they:

1. Did not comply with the above inclusion criteria.
2. Had participated in focus group and pilot study.
3. The research assistant was excluded from the study.

3.5. RESEARCH PROCEDURES

3.5.1. DATA COLLECTION

Permission was granted by the Durban Metropolitan Fire Department (Appendix B) to visit the various stations and the researcher was accompanied by a leading firefighter who assisted the researcher in locating the fire stations as well distribution, collection and separation of the research material. The researcher approached the firefighters in the duty office where they were briefed on the aims and objectives of the study. The firefighters were then presented with a Letter of Information (Appendix G) and Informed Consent forms (Appendix H) by the researcher and the assistant. All questions regarding the questionnaire and the

study were answered by the researcher. The completed questionnaires and forms were collected by the researcher and assistant who separated the Informed Consent forms from the questionnaires. A sheet detailing the names of the stations and the number of questionnaires received was pasted on a box. All the completed questionnaires were placed in this box and were not accessed until all stations were visited. This was done to protect the confidentiality of the participants.

The researcher and the sample population met only once in the design of this study. This occurred during data collection, at the actual time that the questionnaires were administrated and collected. This single meeting ensured that the study was statistically viable, in that all concerns, questions and areas of ambiguity of the respondents were addressed.

3.5.2. ETHICAL CONSIDERATIONS

Access to the questionnaires was limited to the researcher and the supervisor of this study. Salant and Dillman (1994) define anonymity as the inability to associate individual people with specific questionnaires. This was maintained throughout the study as participants were asked not to write their names anywhere on the questionnaires. As no study should be conducted under circumstances in which total disclosure of the aims and purposes of the study can not be presented, a Letter of Information and Informed Consent forms (Appendices G and H) were issued to the participants prior to the administration of the questionnaire. The above forms were separated from the questionnaires so that no form could be correlated any questionnaire. This fulfilled the purpose of confidentiality which Salant and Dillman (1994) define as the security of research data resulting in the inability to associate individuals with specific questionnaire responses. The data was coded and no participants' names were revealed in neither the analysis nor the reporting of the results.

3.6. RESEARCH TOOL

The questionnaire method of data collection was used in this study. A questionnaire is a research tool with open and/or closed questions or statements to which the sample participants must respond (De Vos, 2001). A questionnaire can be either structured or unstructured. A structured questionnaire provides options to each question and the participant is required to merely mark the applicable answer while an unstructured questionnaire requires the participant to answer in their own words (Babbie, 1998). For this study, a structured questionnaire was designed by the researcher by reviewing the literature (Louhevaara, 1984; Sykes, 1993; Nuwayhid *et al*., 1993; Reichelt and Conrad, 1995; Donovan and McConnell, 1998; Guidotti, 1998) and referring to validated questionnaires on similar topics (Rosenstock *et al*., 1984; Mechem *et al.*, 2000; Twizere, 2004).

3.6.1. QUESTIONNAIRE DEVELOPMENT

Three pre-validated questionnaires were studied when designing the questionnaire- the first one was a study done on firefighters to assess the occupational injuries in an urban Fire Department in Philadelphia in 2000 (Mechem *et al.*, 2000) and the second was a study on the development and validation of a self-administered occupational health history questionnaire (Rosenstock *et al*., 1984). The third study was a profile of WRMSIs in professional soccer players in Rwanda (Twizere, 2004). While this third study had no relevance to firefighters, the researcher gained an understanding from this study as to how to go about attempting an injury prevalence investigation.

The questions were constructed by the researcher and the above questionnaires were used merely as a guide. In addition to the above studies, the questionnaire was designed in such a way that it would address all possible risk factors contributing to the development of WRMSIs as has been found in the literature on firefighters as well as in previous studies outcomes regarding risk factors for injury in other occupations- chiropractors, and physical therapists (Tim, 1996;

Holder *et al.,* 1999; West and Gardner, 2001; Glover *et al.,* 2005) ambulance personnel (Vlok, 2005) and refuse truck drivers (Ramroop *et al.*, 2006).

The questions were constructed for their ease of understanding (Dyer, 1997). Sudman and Blair (1998) describe closed questions as used in the questionnaire of this study as appropriate as they encourage response by making the completion of the questionnaire easy, are less time consuming, simplify coding for data analysis and reduce the amount of probing needed. Welman and Kruger (1999) recommend that even if a questionnaire is made up exclusively of closed questions, it should include with an open question in case anything of importance to the participant has omitted.

Thus, the researcher utilized this method of questionnaire construction. Tables were constructed with pre-determined answers which only required the participant to tick the appropriate answers. Some open- ended questions were included, in order to allow the participant to provide additional information. The initial questionnaire had six parts which dealt with identification, area and nature of injuries as well as treatment sought for injuries, followed by a variety of questions dealing with risk factors for injury (Appendix F).

3.6.2. VALIDITY

According to Leedy (1993) and Bernard (2000), validity refers to the accuracy and trustworthiness of instruments, data and findings in research, thereby ensuring that future research utilizing the particular tool is accurate or, simply put, to assess if one is *actually* measuring with the tool what they *want* to measure.
The questionnaire designed by the researcher was pre-tested in order to ensure that it would be effective in obtaining the information that was required for the investigation. Aaker *et al.* (1995) recommends questionnaire pre-testing as a way of identifying and eliminating those questions that are in excess or are ambiguous. Once deficiencies have been recognized and corrected, the final questionnaire is ready for data collection. The questionnaire in this study was therefore pre-tested for reliability and validity by a Focus Group and a Pilot Study.

3.6.2.1. FOCUS GROUP

A Focus Group is a “carefully planned series of discussions designed to obtain perceptions on a defined area of interest” (Krueger and Casey, 2000). This is useful in the research process to acquire further ideas and understanding on the research topic (Morgan, 1998).

The Focus Group aims to achieve face and content validity of a questionnaire by identifying any discrepancies, uncertainties, ambiguity and deficiencies. Morgan (1998) suggested that a Focus Group should consist of 6-8 participants, while some researchers have used 10 (MacIntosh, 1981) and others up to 15 (Goss and Leinbach, 1996). Focus Group participants should be selected based on their knowledge and experience on the topic of interest as well as on their similarities to the sample that will eventually complete the questionnaire. Changes to the questionnaire can be discussed and appended based on the recommendations of the participants, resulting in a revised questionnaire more suited to the task of data collection (Holder *et al.*, 1999; Bernard, 2000).

The Focus Group of this study was held at the Durban University of Technology and consisted of 2 firefighters, 5 chiropractors, and the researcher. All participants were briefed on the aims of the study and were asked not to communicate any information about the questionnaire to anyone. The firefighters present were also informed that due to their participation in the Focus Group, they would be excluded from the study. All participants read the Letter of Information (Appendix C), Informed Consent forms (Appendix E), and signed Code of Conduct form (Appendix D), before the Focus Group commenced and discussions pertinent to the questionnaire began.

The questions were then discussed in sequential order (Morgan, 1998) and participants were asked to comment and recommend any changes that would improve the quality of the questionnaire for the investigation. In addition, the firefighters were asked to suggest any further aspects of the occupation that related to the study, but was not represented in the questionnaire. All

submissions were discussed and critically analyzed prior to omission or addition of questions or changes.

3.6.2.2. FOCUS GROUP DISCUSSION

Changes proposed by the Focus group included adding or deleting questions, corrections to spelling and grammar, widening the figures to obtain more accurate data and changing the presentation of questions to prevent ambiguity.

PART A:

Part A of the questionnaire dealt with determining demographic and employment details.

How old are you?

The Focus Group agreed that the ranges determined by researcher were sufficient and no changes were made to this question.

Are you male or female?

As this is a standard question in most questionnaires obtaining demographic information, no changes were proposed for this question.

For how many years have you been in the fire service?

The increments for the years in service were changed and this question was moved to the end of Part A in order to group the employment questions after the demographic questions.

What is your employment status?

It was pointed out in the Focus Group that all active firefighters worked four shifts a week. Hence there was no distinction between full and part time workers. Therefore this question was omitted.

To which ethnic/cultural group do you belong to?

The Group agreed that a bracketed addition of “for statistical purposes only” to this question was more politically correct.

What is your marital status?

No changes were proposed for this question.

What is your position in the fire service?

The firefighters at the Focus Group reported that the position of "Learnership fighter" was non-existent and that rookie firefighters performed similar duties to leading firefighters. In addition, the position of 'Division officer" was not part of the Chain of Command at the Durban Metropolitan Fire Department. Therefore, these positions were deleted from the question. It was also suggested that the firefighters be asked what fire alarms they usually attend. This was important as the city firefighters mainly attend ship, structural fires and Motor vehicle Collisions (MVC) whereas the suburban firefighters attend mostly veld fires. This was significant as the risks faced by both with regards to injuries were anecdotally thought to differ.

PART B:

This section dealt with obtaining data regarding the history of injuries.

How many injuries have you sustained during training or on the fire ground in the last three years?

A question regarding whether the firefighters were suffering from a WRMSI at the time of answering the questionnaire was suggested and added after unanimous agreement. This question followed the added question.

Which parts of the body were injured?

It was proposed that instead of a table detailing the parts of the body that were injured, a picture should be inserted and the participants should be asked to draw a cross on the affected area(s) as this will produce a more accurate result.

How did you injure the body part(s)?

The Focus Group was asked to suggest any further additions to this list of possible mechanisms of injury. Dehydration, fatigue, heat exhaustion, smoke inhalation, chemical exposure and running were all suggested additions to this question.

What was the diagnosis of the injury?

The Group suggested changing the presentation of this question so that it would be easier to understand. This question was changed to “what would you describe your injury as?” and an open-ended question was added to allow the firefighters to express any injury type that was not listed.

What treatment did you receive?

No changes were proposed to this question.

What treatment was administered?

It was decided that this question regarding specific treatment obtained be omitted as the firefighters may not know the nature of their treatment in detail.

Was the treatment successful?

No changes were made to this question.

How much time was lost from work due to injury?

No changes were made to this question.

PART C:

This section dealt with health and fitness.

How would you rate your general health?

No changes were made to this question.

What is your height?

It was initially deliberated whether the firefighters would know their height or weight but the firefighters present assured the Focus Group that due to fitness evaluations, the firefighters are aware of these figures.

What is your weight?

No changes were made to this question.

On average, how often do you train per week?

No changes were made to this question.

On average, how often do you train for in one session?

No changes were made to this question. At this point it was suggested that a question regarding stretching before training be added to the questionnaire.

Do you have a warm-up session?

It was decided to re-word this question to read "Do you have a warm-up session prior to training?" It was also suggested that the length of the warm of session should also be determined and the question was included accordingly.

Do you perform or undertake strength training as part of your work out?

No changes were made to this question.

PART D:

This section of the questionnaire assessed the stress levels of firefighters as well as lifestyle factors. This section was designed to assess the firefighter's perception of their stress level as well as to determine if the firefighter suffers from any constitutional symptoms or illnesses related to stress as indicated in the literature. This was followed by questions on history of smoking.

How would you rate your stress levels generally?

No changes were made to this question.

How would you describe your sleeping patterns?

No changes were made to this question.

How would you describe yourself in the working environment?

No changes were made to this question.

Do you suffer from any of the following stress-related illnesses?

No changes were made to this question. However it was suggested that a question on stress related symptoms.

Are you a smoker?

No changes were made to this question.

If yes, on average how many cigarettes do you smoke a day?

No changes were made to this question. It was pointed out that the questionnaire did not determine a previous history of smoking and the appropriate questions were added.

PART E

This section dealt with the protective gear worn by the firefighters. The first question asked to firefighters to identify which of the regulated PPE they use followed by questions regarding comfort and fit of their gear. The section ended with an open-ended question asking the firefighter to elaborate on how their gear interferes with their tasks.

Which of the following protective gear do you utilize during fire fighting tasks?

The firefighters added fatigues to the list as the researchers did not have this on the list of PPE. No further changes were made to this question.

How comfortable are you in your protective gear?

No changes were made to this question.

Do you feel that your posture or movement is sometimes hindered by gear during fire fighting?

No changes were made to this question.

PART F:

Part F dealt with investigation the type and amount of injury prevention advice firefighters receive. Firefighter had to report on the amount of advice they were given with regards to correct working postures, correct lifting techniques, nutrition and sufficiency of advice received.

Are you given advice regarding correct working postures?

No changes were made to this question.

Are you given advice regarding correct lifting techniques to protect your lower back?

No changes were made to this question.

Are you given nutritional advice on what to eat and drink?

No changes were made to this question.

Do you feel that you have been given sufficient training and advice regarding the prevention of musculoskeletal injuries?

No changes were made to this question.

No further changes were made to the questionnaire and the tables were modified and justified for clarity. It was unanimously agreed that the instructions on the questionnaire were clear, understandable and objective and that the questions had a logical flow.

3.6.2.3. PILOT STUDY

A pilot study is a preliminary or trial run of a larger study that is conducted in preparation for that study to determine the feasibility of a research tool (Trochim, 2001).

The aim of the pilot study was to determine if the sample population could relate to the questionnaire and if any further discrepancies or errors can be brought to the fore. In this light, Fink and Kosecoff (1985) describe that the purposes of a pilot study is to determine:

- If the questionnaire provides the necessary information.
- If certain questions are redundant or misleading.
- If the questions are appropriate for the individuals who will be participating in the study.
- If the information the researcher collects enable him/her to use the surveys properly.
- If the procedures are standardized.
- The consistency of the information obtained.
- The accuracy of the information obtained.

Three firefighters, who would have met the inclusion criteria, completed the questionnaire. They reported that the questionnaire was easy to understand and was straight forward. The time taken to fill out the questionnaire was 10-15 minutes.

No changes were made to the post-Focus Group questionnaire (Appendix K).

3.6.2.4. FINAL QUESTIONNAIRE

The questionnaire (Appendix K) consisted of six parts.

Part A dealt with identification and demographical information as well as the position of the firefighter in the department, number of years in service and the type of fire alarms that they mainly attend.

Part B asked the firefighter to report on his/her history of injuries in the last three years. The area and nature of the injuries, as well as the treatment obtained and time lost from work was covered.

Part C assessed the fitness level of the firefighter. Some anthropometrical details were requested, followed by questions on the firefighters' training habits.

Part D dealt with symptoms of stress that the firefighter may/ may not experience. The firefighter was prompted to report on sleeping patterns and various stress-related symptoms, diseases. This section also dealt with the participant's history of smoking.

Part E dealt with the protective gear worn by the firefighter. Participants were asked to report on which protective gear they wear and comfort of their gear.

Lastly, ***Part F*** assessed preventative measures. The participants were asked questions about any information and advice that had been given to them in order to protect themselves against WRMSIs.

3.7. DATA CODING AND CAPTURING

Preliminary preparation of data obtained from questionnaires includes data coding and statistical adjustment (Aaker *et al.,* 1995). The questionnaires were accessed only after the researcher visited all the stations in the Durban Metropolitan Fire Department. All the questionnaires were checked to identify omissions or errors in the responses. To simplify the data analysis without distortion of interpretation, illegible or missing answers were coded as '0.'

The questionnaires were coded using the Microsoft Excel package. A spreadsheet was designed where columns provided variable identification and

response values were then input. Once this was completed, a statistical software program, Statistical Package for the Social Sciences (SPSS Version 15.0) (SPSS Inc., Chicago, Illinois, USA) was used to generate the results for this study. This was done by a professional statistician who was employed for the analysis of the data.

3.8. STATISTICAL METHODOLOGY

A statistic is a quantity that is estimated from a sample of data and is used to provide information regarding unknown parameters in the sample being tested (Katzenellenbogen *et al*., 1997; Easton and McHoll, 2008).

According to Howell (1999), statistical procedures are divided into two areas i.e. inferential and descriptive statistics. Inferential statistics are defined as techniques applied to samples in order to make inferences about populations while descriptive statistics are techniques used to organize, summarize and describe data (Howell, 1999).

In this study, the following descriptive and inferential statistics were used.

3.8.1. DESCRIPTIVE STATISTICS

3.8.1.1. FREQUENCIES AND PERCENTAGES

Bar graphs were used in this study to display data as, according to Huysamen (1998), people are more likely to remember pictures, symbols and graphic representations than written words. In addition, the use of graphic representations and tables are effective when presenting data coherently (Howell, 1999).

3.8.2. INFERENTIAL STATISTICS

Inferential statistics deals with inferring characteristics of a population from characteristic samples (Howell, 1999). This also allows researchers to establish how two or more variables are related to each other (Sekaran, 2000). The following inferential statistics were used in this study**:**

3.8.2.1. PEARSON CHI-SQUARE

The Chi-Square test is defined as a statistical test often used for analyzing categorical data (Howell, 1999). Thus, this test assists in the analysis of frequency or categorical data. As both frequency and categorical were obtained in this study, the statistician appropriately employed this test in the analysis of the data.

3.8.2.2. t-TEST

This test is used to determine whether “nominal groups of data differ from each other on a variable of interest” (Sekaran, 2000).

P-Value

The probability value (p-value) of a statistical hypothesis test is the probability of getting a value of the test statistic as extreme as or more extreme than that observed by chance alone, if the null hypothesis H0, is true. The null hypothesis represents a theory that has been put forward, either because it is believed to be true or because it is to be used as a basis for argument, but has not been proved (Trochim, 2001). It is the probability of wrongly rejecting the null hypothesis if it is true.

It is equal to the significance level of the test for which we would only just reject the null hypothesis. The p-value is compared with the actual significance level and if it is smaller, the result is significant. Therefore,

if the null hypothesis were to be rejected at the 5% significance level, this would be reported as "p < 0.05".

Small p-values suggest that the null hypothesis is unlikely to be true. The smaller it is, the more convincing is the rejection of the null hypothesis. It indicates the strength of evidence for say, rejecting the null hypothesis H0, rather than simply concluding "Reject H0' or "Do not reject H0" (Easton and McHoll, 2008).

In this study, a p value of < 0.05 was considered statistically significant.

3.9. CONCLUSION

This chapter focused on sampling, the research tool, data collection methods and the statistical methods employed in the study. The subsequent chapter will focus on the results of the study followed by the discussion of the findings in Chapter Five.

CHAPTER FOUR: PRESENTATION OF RESULTS

4. 1. INTRODUCTION

Results of the statistical analysis of the data are presented in this chapter.

4.2. DATA

- ***PRIMARY DATA***

The primary data for this study was collected by means of a self-administered, quantitative questionnaire designed specifically for this study (Appendix K).

- ***SECONDARY DATA***

This included all information sourced in the development of the questionnaire and the write up of this dissertation. Journal articles, published dissertations, Internet websites, books and government publications were evaluated and included in this study and were referenced accordingly. The secondary data will be compared to the outcome of the results of this study.

4.3. REVIEW OF AIM, OBJECTIVES AND HYPOTHESES OF THE STUDY

The aim of this study was to determine the prevalence and the risk factors associated with WRMSIs in the Durban Metropolitan Fire Department.

OBJECTIVES AND HYPOTHESES

4.3.1. The first objective was to determine the demographic data of the firefighters**.**

4.3.2. The second objective was to determine the whether demographic data was associated with the prevalence of WRMSIs among firefighters.

4.3.2.1. Null Hypothesis One: There is no significant relationship between demographic data and the prevalence of WRMSIs.

4.3.3. The third objective was to determine the prevalence and history of WRMSIs in the firefighters of the Durban Metropolitan Fire Department.

4.3.4. The fourth objective was to determine whether selected factors are associated with the prevalence of WRMSIs.

4.3.4.1. Null Hypothesis Two: There is no significant relationship between selected factors and the prevalence of WRMSIs.

4.3.5. The fifth objective was to assess the strength of the relationships of selected factors with the most common injuries presented in the results.

4.3.6. The sixth objective was to recommend preventative measures based on the results and the reviewed literature.

4. 4. RESPONSE RATE

A minimum of a hundred firefighters (n=100) were randomly selected to participate in this study which represented 28% of the total active firefighter population (350). However, the researcher aimed to target as many of the 350 active firefighters in the Durban Metropolitan Fire Department. Of the 350 firefighters, 143 firefighters agreed to voluntarily participate (n=143). This translated into a 41% response from the total population of firefighters.

Station	Number of Responses
Durban North	4
Phoenix	6
Ntuzuma	6
Umhlanga	10
Amanzimtoti	9
Umlazi	7
Prospecton	5
Mobeni	5
Pinetown	10
Central	30
Congella	9
Jacobs	7
Chatsworth	5
Tongaat	6
Pinetown South	5
Gilletts	5
Westville	5
Queensburgh	4
Hammersdale	5
Total:	143

Table 4.1: Number of responses from each station in the Durban Metropolitan Fire Department

This moderate response rate can be attributed to the fact that the researcher personally approached the firefighters and collected the questionnaires from them on the day of administration. In addition, the design of the questionnaire encompassing closed questions that required the firefighters to merely tick the appropriate box was helpful as firefighters readily agreed to participate as the questionnaire was not too cumbersome to complete. The available firefighters were given time at the station as the divisional commander at each station allowed the researcher speak to the available firefighters in the boardroom were they could complete the questionnaires. The authorities at all the stations were very accommodating to this study which contributed considerably to the response rate.

The response rate in this study was higher than that achieved by Moran and Colless (1995) who achieved a response rate of 37% when they assessed the reactions of firefighters after disaster response and Chan *et al.* (2004) who achieved a 27% response rate when assessing the commitment and participation of firefighters in the worker's union. The response rate of this study was also higher than that of the Scottish Parliament (2006) who conducted research on rural, auxiliary and volunteer firefighters which achieved a response rate of 30%. This could be due too the fact that all of the above studies posted the questionnaires and did not use a direct contact as used in this study. However, it must be noted that due the emergency nature of the firefighter occupation, firefighters were constantly out on calls that kept them busy for hours. Hence, the response rate of 41% was considered substantial.

This could also have possibly been due to the sample size taken from Durban only, while other studies have taken samples from all provinces of South Africa, which utilized postage, e-mail and / or fax to the return of questionnaires (Reubens, 1996; Hunter, 2004).

4.5. RESULTS

4.5.1. OBJECTIVE ONE: To determine the demographic data of the firefighters

4.5.1.1. Age

There were 143 responses to the survey. The age distribution is shown in Figure 4.1. The majority of the sample was 25-34 years old (47.6%). Only 10 (7%) of the sample were female.

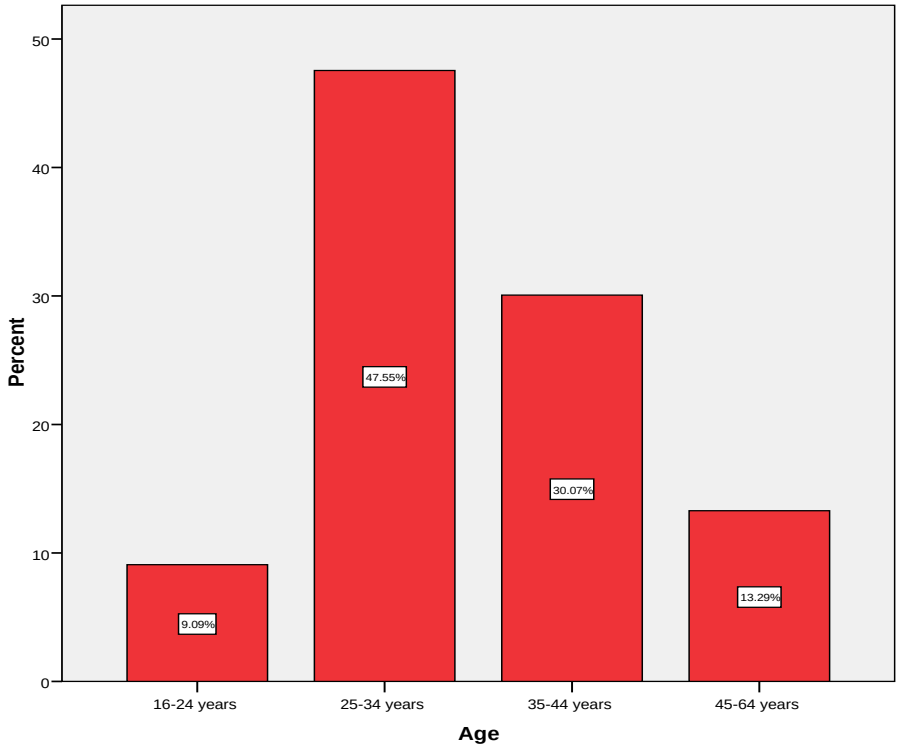

Figure 4.1: Age distribution of sample (n=143)

The majority of the sample (47.6%) was in the 25-34 year old age bracket. This trend is seen throughout the emergency rescue care services as those working in the field tend to be younger due to the physically demanding nature of the occupation. As these employers get older, they tend to take up posts in administrative settings which remove them from the field (Bateman, 2007).

4.5.1.2. Racial distribution

The majority of respondents were Black (46.9%) while 28.7% were Indian and 14% Coloured. Only 10.5% were White.

Table 4.2: Racial distribution of sample

	Frequency	Percent
Black	67	46.9
White	15	10.5
Coloured	20	14.0
Indian	41	28.7
Total	**143**	**100.0**

According to the Durban Metro Local Agenda (2008), the majority of residents of Durban are Black (56%), there is a large Indian community (27%), and a minority White community (14%). Only 3% of Durban's population are Coloured.

Therefore, based on the racial distribution of the city, the sample in this study is sufficient to be representative of the city's population.

4.5.1.3. Marital status

Just over half the participants were married (50.3%). Fourteen firefighters in the sample were divorced.

Table 4.3: Marital status of sample

	Frequency	Percent
Single	52	36.4
Married	72	50.3
Separated	3	2.1
Divorced	14	9.8
Widowed	2	1.4
Total	**143**	**100.0**

This result of 9.8% of the sample being divorced is consistent with that of Oosthuizen (2004) who found an 8.3% rate of divorce in 2003 from a sample of 241 firefighters in the Metropolitan Municipality in South Africa. Oosthuizen (2004) however, did not evaluated firefighters for marital separation.

This increased rate of divorce is consistent with the findings of Hildebrand (1984) and Blum (1994) who found an increased frequency of divorce and marital problems among firefighters due to the psychological stress associated with the occupation.

4.5.1.4. Position in the fire service

The vast majority of participants were leading firefighters (86.71%), while there were 18 station officers (12.59%) and one division commander (0.7%).

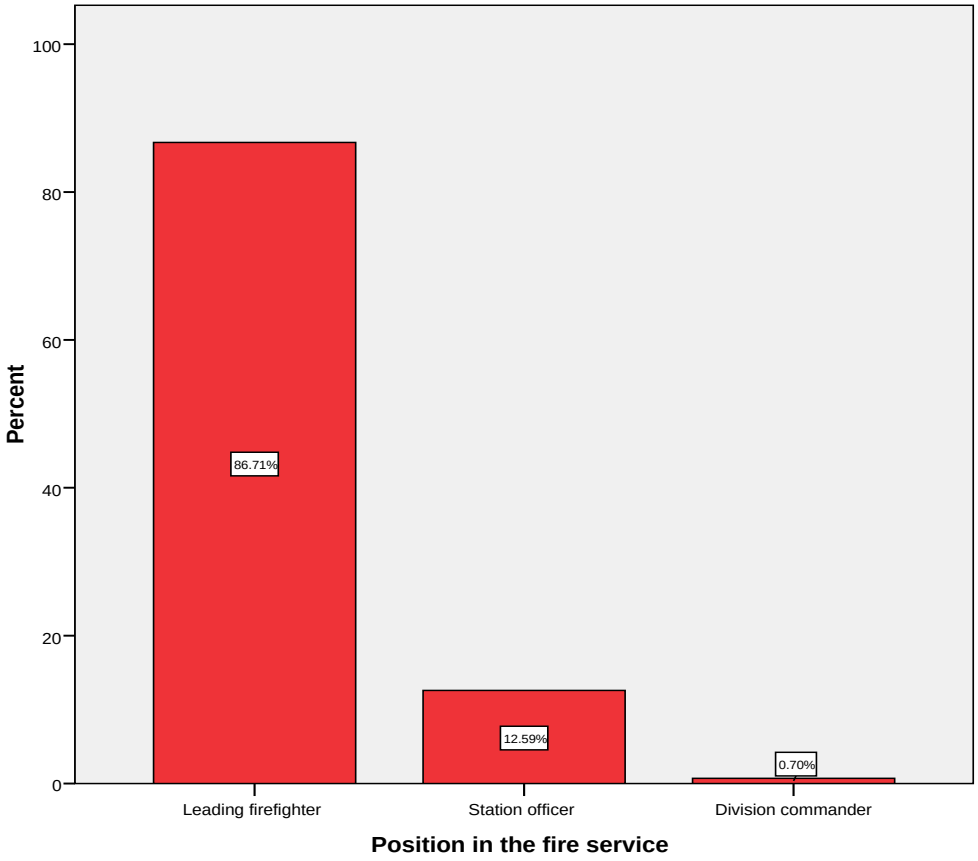

Figure 4.2: Position in the fire service of study participants (n=143)

This is consistent with the universal structure of all fire departments where the majority of the staff are leading firefighters with a hierarchy of officers and commanders who manage the leading firefighters at all emergencies (IFSTA, 1998).

4.5.1.5. Number of years in the fire service

Most of the sample has been working in the fire service for 3-5 years (n=45) and 6-10 years (n=42).

Table 4.4: Number of years in the fire service

	Frequency	**Percent**
3-5years	45	31.5
6-10 years	42	29.4
11-15 years	28	19.6
16-20 years	12	8.4
21-25 years	9	6.3
26-30 years	5	3.5
31-35 years	1	.7
More than 36 years	1	.7
Total	**143**	**100.0**

This finding is consistent with the age statistics (Figure 4.1) as most of the firefighters in this sample fell into the 24-35 years age bracket.

4.5.1.6. Types of fires attended

Urban fires were the most frequently (70%) attended in this sample.

Table 4.5: Types of fires attended

	Frequency	**Percent**
Urban fires (Structural, ship and MVC fires)	100	69.9
Rural fires	43	30.1
Total	**143**	**100.0**

The large percentage of firefighters who attend urban fires was expected as Durban Metropolitan Fire Department is an urban Fire Department. Furthermore, the stations closer to the Central Business District (CBD) have larger staffs than the suburban and rural stations (George, 2008).

4.5.2. OBJECTIVE TWO: To determine the whether demographic data was associated with the prevalence of WRMSIs among firefighters.

Of the demographic factors, only ethnic group was significantly associated with injury (p = 0.026). Coloured and Indian participants were more likely to injure themselves that other race groups.

Table 4.6: Demographic factors for injury

		Injured				p value
		No		Yes		
		Count	%	Count	%	
Age	16-24 years	3	23.1%	10	76.9%	0.885
	25-34 years	11	16.2%	57	83.8%	
	35-44 years	9	20.9%	34	79.1%	
	45-64 years	4	21.1%	15	78.9%	
	Older than 64 years	0	.0%	0	.0%	

This study found no significant relationship between age of the firefighters and the prevalence of WRMSIs. It was decided in the methodology that only firefighters involved in active firefighting would qualify to participate in this study and the administrative staff be excluded. The older, more experienced firefighters generally move up the chain of command in the fire service. They are not actively involved in firefighting and tend to form part of the strategic planning force (Bateman, 2008). Due to this methodological impact, the significance of age and the prevalence of WRMSIs are not present in the sample population of this study and are viewed as a limitation of this study.

Table 4.6: continued

		Injured				p value
		No		Yes		
		Count	%	Count	%	
Gender	**Male**	25	18.8%	108	81.2%	1.000
	Female	2	20.0%	8	80.0%	

This study also found that there was no correlation between gender and the prevalence of WRMSIs. This can be attributed to the fact that only 10 (7%) of the sample was female. Thus, with such a considerable difference in the numbers of both sexes, the results of this study are not reliable in determining the correlation between gender and the prevalence of WRMSIs in the fire service as the sample was not comparable.

Table 4.6: continued

		Injured				p value
		No		Yes		
		Count	%	Count	%	
Ethnic group	Black	14	20.9%	53	79.1%	***0.026***
	White	6	40.0%	9	60.0%	
	Coloured	0	.0%	20	100.0%	
	Indian	7	17.1%	34	82.9%	
	Other	0	.0%	0	.0%	

It was found that the Coloured and Indian participants were most likely to sustain injuries (p=0.026). This was similar to the finding by Vlok (2005), who found that low back pain was more prevalent among Indian (92.3%) and Coloured (91.7%) of participants in the Emergency Rescue Care Services.

This finding was further comparable with the literature as a study by Docrat (1999) found that the lifetime incidence of LBP among Indian and Coloured South Africans was 78.2% and 76.6% respectively. Additionally, Van der Meulen (1997) found the lifetime incidence among Black South Africans was 57.6%.

However, while this difference is accepted in the literature, the reason for the Coloured and Indian ethnic groups being predisposed to injury is not fully understood. It would be interesting to investigate this relationship as an area for future research.

Table 4.6: continued

		Injured				p value
		No		Yes		
		Count	%	Count	%	
Marital status	Single	14	26.9%	38	73.1%	0.197
	Married	11	15.3%	61	84.7%	
	Separated	0	.0%	3	100.0%	
	Divorced	1	7.1%	13	92.9%	
	Widowed	1	50.0%	1	50.0%	

No research could be found with respect to the effect of these factors on the firefighter. It is however of interest to note that there a tendency towards separated and divorced persons is having a higher rate of injury than any other group.

Table 4.6: continued

		Injured				p value
		No		Yes		
		Count	%	Count	%	
Position in the fire service	Leading firefighter	22	17.7%	102	82.3%	0.530
	Station officer	5	27.8%	13	72.2%	
	Division commander	0	.0%	1	100.0%	
	Regional commander	0	.0%	0	.0%	
	Chief/ Deputy Chief	0	.0%	0	.0%	

No research could be found with respect to the effect of these factors on the firefighter. However, the methodological limitation of excluded “inactive” firefighters may have impacted on this result. The leading firefighters sustained the most injuries due to their increased activity and exposure. The results also tend to indicate that the higher up the chain of command, the rate of injury increases as the level of activity decreases (i.e. administrative tasks versus on the fireground).

Table 4.6: continued

		Injured				p value
		No		Yes		
		Count	%	Count	%	
How many years have you been in the fire service?	3-5years	8	17.8%	37	82.2%	0.431
	6-10 years	8	19.0%	34	81.0%	
	11-15 years	5	17.9%	23	82.1%	
	16-20 years	1	8.3%	11	91.7%	
	21-25 years	2	22.2%	7	77.8%	
	26-30 years	2	40.0%	3	60.0%	
	31-35 years	0	.0%	1	100.0%	
	More than 36 years	1	100.0%	0	.0%	

The results suggest that the rate of injury decreases with the number of years of experience in the fire service. This is seen as a gradual decrease in the number of injuries as the years of service increase. Also, this could be attributed to the fact that firefighters move higher up the chain of command after many years in the fire service and thus undertake more administrative and delegative tasks than firefighting and rescue activities. Their “lack” of firefighting and rescue activities may result in the apparent decrease in injury prevalence with increased years in the fire service in this particular study which required the respondents to be active firefighters.

Based on this, null hypothesis one is rejected ($p < 0.005$) – there is a significant relationship between demographic data and the prevalence of WRMSIs.

4.5.3. OBJECTIVE THREE: To determine the prevalence and history of WRMSIs in the firefighters of the Durban Metropolitan Fire Department.

4.5.3.1. Point prevalence

At the time administration of the questionnaires, 33.6% of the sample was suffering from a WRMSI. Hence the period prevalence was 33.6%.

Table 4.7: Point prevalence

	Frequency	**Percent**
Yes	48	33.6
No	95	66.4
Total	143	100.0

4.5.3.2. Period prevalence of WRMSI

Between 0 and 5 injuries had been sustained during training in the last 3 years and up to 6 injuries on the fire ground. In this sample, 51.7% had not sustained any injuries in training and one third had not sustained any injuries on the fire ground in the last 3 years. The total number of training injuries in the last 3 years was 84, an average of 28 injuries (risk of 19.6%) a year. The total number of fire ground injuries was 154 over 3 years, an average of 51 injuries (risk of 35.7%) a year. Therefore the total risk for injury is 55.3 % per year inclusive of fireground and training injuries.

Table 4.8: Period prevalence of WRMSI

	Training		Fire ground	
	Frequency	**Percent**	**Frequency**	**Percent**
0	74	51.7	48	33.6
1	58	40.6	51	35.7
2	9	6.3	32	22.4
3	1	.7	11	7.7
4	0	0	0	0
5	1	.7	0	0
6	0	0	1	.7
Total	143	100.0	143	100.0

This finding of a 55.3% annual risk of injury is higher than that of Mechem *et al.* (2000) and Karter and Molis (2007) where 33% and 44.4% of the injuries reported respectively were WRMSIs.

However, it must be noted that both these studies investigated WRMSIs under the category of “sprains, strains and muscular pain.” Firefighters who did not fall under this umbrella and sustained other WRMSIs (e.g. fractures, dislocations

and ligamentous tears) may not have responded resulting in a possible underestimation of the prevalence of WRMSIs. Conversely the annual risk of sustaining WRMSIs during training was found by Bylund and Ornstig (1999) 51% in Sweden while the annual risk of training injuries in this sample was 19.6%.

Therefore from the results of this study, we concur with Karter and Molis (2003) and Mechem *et al.* (2000) yet not with Bylund and Ornstig (1999), it can thus be concluded that the prevalence of WRMSIs in the fire service in Durban seems to support the more recent studies.

4.5.3.3. Area of injuries

Low back injuries were sustained by almost half the sample over a three year period, while knee injuries were the second most common injuries (22.5%) and shoulder and ankle injuries were sustained in nearly 20% of the sample.

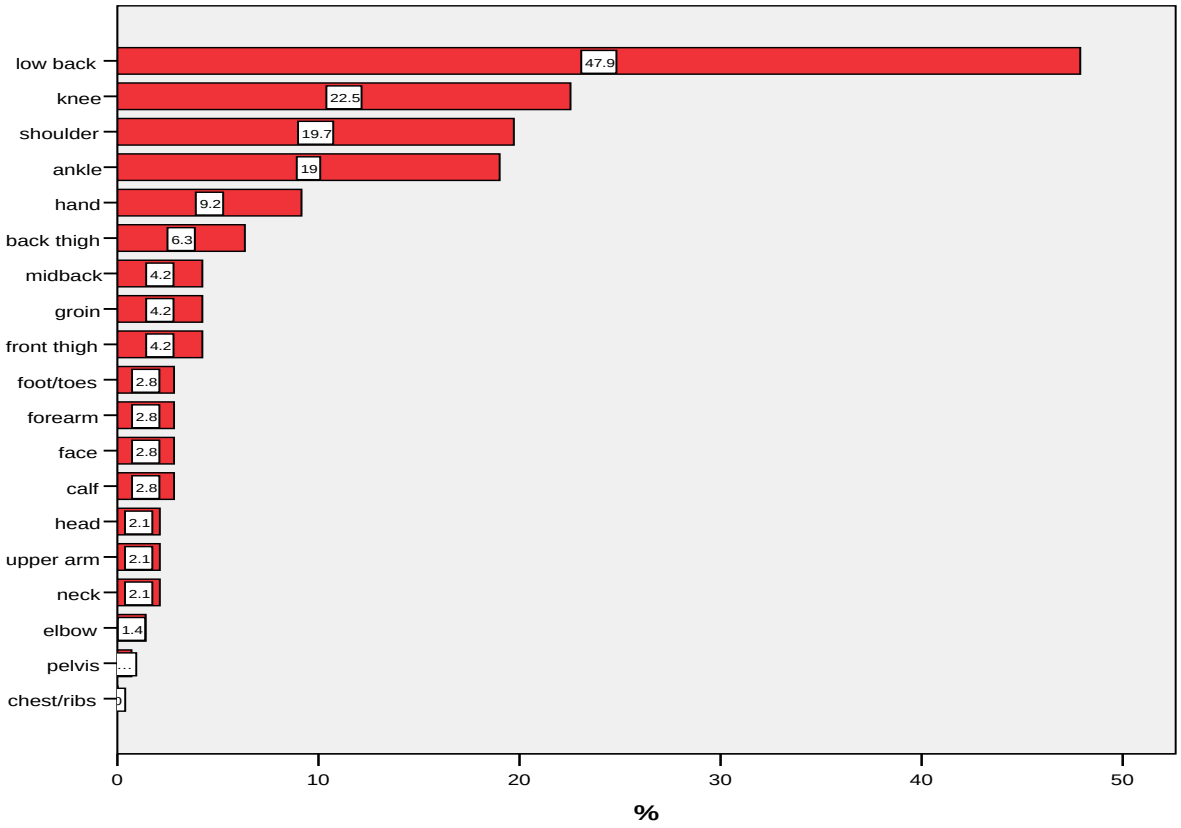

Figure 4.3: Area of injuries in the last 3 years.

The high rate of low back injuries was expected, as it was the focus of most studies on firefighter WRMSIs (Nuwayhid *et al.,* 1993; Reichelt and Conrad, 1995; Guidotti, 1998). The high rate of knee and ankle injuries in this study is similar to research findings by Marriot and Lillicrap (1994) and Bylund and Ornstig (1999). The results have thus reiterated the high rate of occupational low back, knee and ankle injuries in the fire service, but have also highlighted the shoulder as area that is susceptible to injury. Further comparison is limited as a result of the reporting mechanism utilized in previous studies (Mechem *et al.*, 2000 and Karter and Molis, 2003). Future studies should utilize a standard reporting system that incorporates a more detailed list of injuries and perhaps followed by an open-ended question to allow firefighters to elaborate on their injuries.

4.5.3.4. Causes of injuries

The most common cause of injury in this study was lifting heavy objects (55.4%). Running and working in awkward positions were responsible for injuries in 44.6% of the sample each.

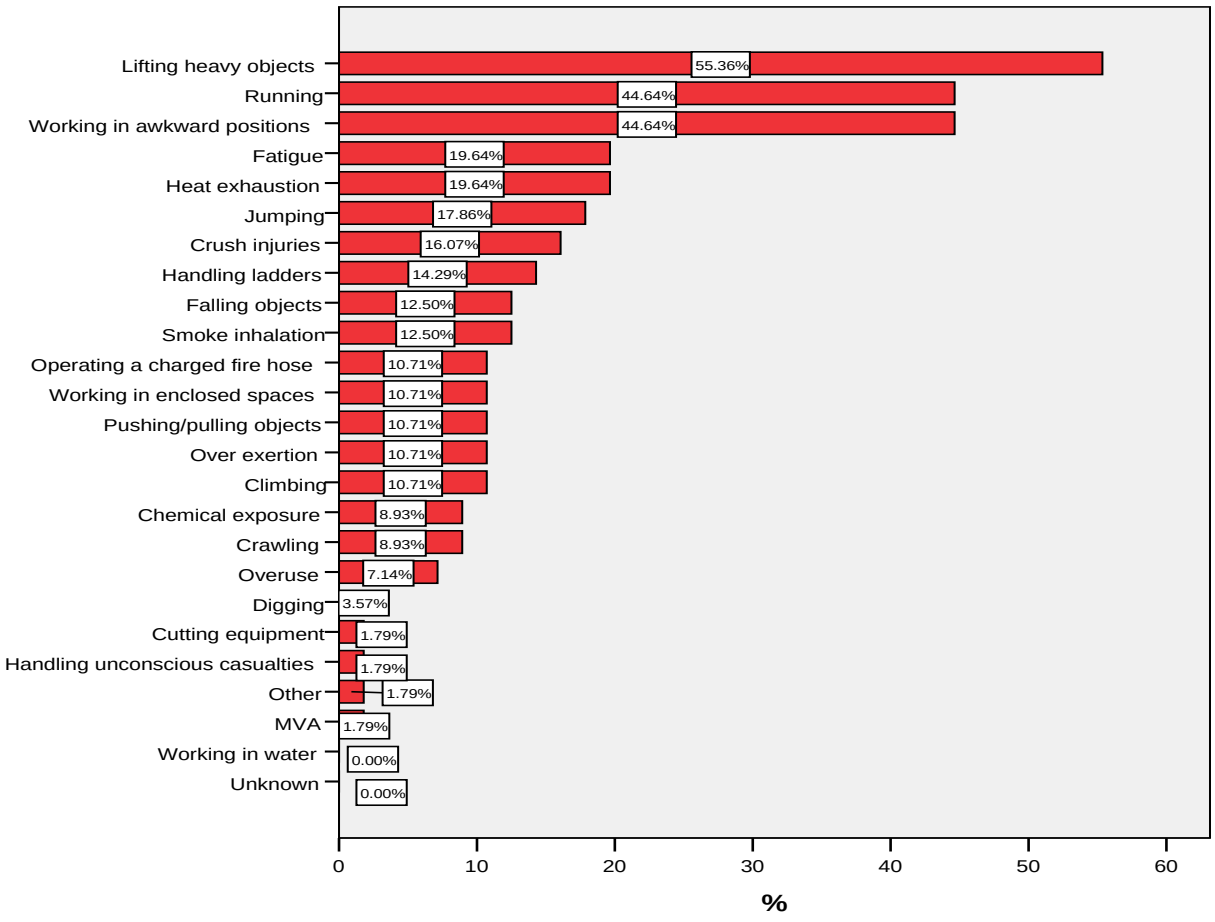

Figure 4.4: Cause of injuries in the last 3 years

The most common cause was lifting heavy objects (55.4%). According to Zenz (1998), work posture should make it possible to retain the joints in mainly neutral positions, i.e. neither heavily flexed nor extended. Work postures in which the trunk is twisted or bent or in a way that the joints are forced to function at their

extreme positions, frequently give rise to musculoskeletal complaints. This was consistent with the finding that low back injuries (Figure 4.3) were the most prevalent. In addition, working in awkward postures may explain the high rate of low back injuries (Figure 4.3). These findings are consistent with those of Nuwayhid *et al.* (1995), Reichelt and Conrad (1995) and Guidotti (1998). The high rate of injuries to the knee could be attributed to running as a causative factor as well as the significance of stress as a risk factor for knee injuries (Table 4.24) as found in the results of this study.

4.5.3.5. Types of injuries

Strains accounted for 40.8% of the injuries, while 25% were sprains, 23% were ligament tears, and 17% contusions.

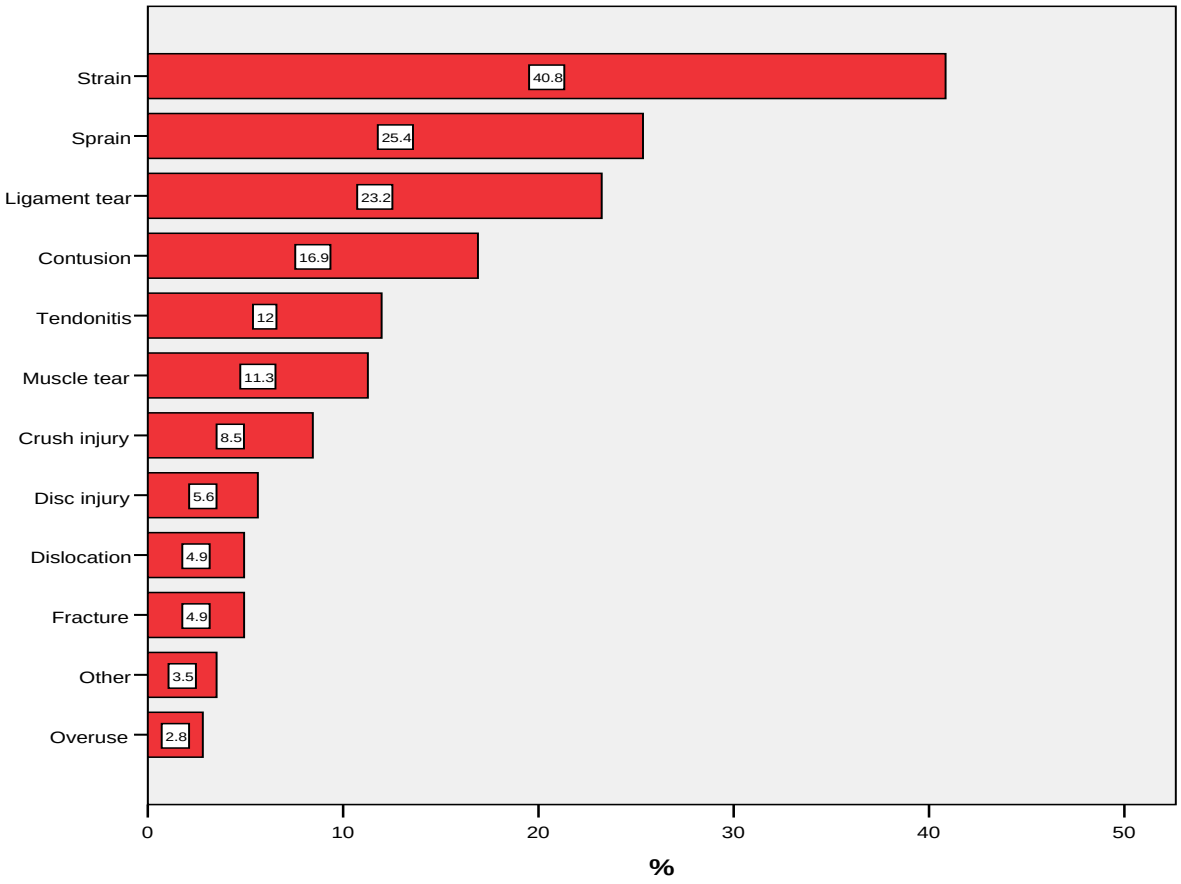

Figure 4.5: Type of injuries in the last 3 years

This 65.8% result of combined prevalence of sprains and strains is higher than that of Marriot and Lillicrap (1994) and Karter and Molis (2003) where sprains and strains were reported at 50% and 33% respectively. These findings were consistent with the National Fire Protection Association in the US (1999) which found that sprains, strains and muscular pain accounted for the highest percentage of the most severe injuries on the fire ground.

These results thus corroborate that of the reviewed literature (Marriot and Lillicrap, 1994 and Karter and Molis, 2003) and highlight ligamentous tears and contusions as other prevalent injuries.

4.5.3.6. Treatment obtained for injuries

In total 116 participants (81.1%) reported injuries in the last 3 years. Of these, the majority of injured respondents used medical treatment for their injuries (52%) while 45% used physiotherapy and 22% used chiropractic.

Table 4.9: Treatment obtained for injuries (n=116)

	Count	Row N %
Medical treatment	60	51.7%
Physiotherapy	52	44.8%
Chiropractic	25	21.6%
Self	39	33.6%
None	9	7.8%
Other treatment	1	.9%

These results may have been influenced by the policy of the Durban Metropolitan Fire Department to refer firefighters with WRMSIs to designated physiotherapists for treatment (George, 2008). Nevertheless treatment was successful in 70% of the cases.

Table 4.10: Success of treatment obtained

	Frequency	Percent
Yes	81	69.8
No	35	30.2
Total	**116**	**100.0**

No research could be found with respect to the treatment obtained by firefighters. Future studies could focus on this area to determine which treatments received the highest success rates and why a large percentage of the treatments sought (30.2%) were unsuccessful..

4.5.3.7. Time lost from work

Most of the injured firefighters (35.7%) did not take time from work. Most lost a week or less (26.6%) while 7% lost more than four weeks from work.

Table 4.11: Time lost from work

		Frequency	Percent
	No Injury	26	18.2
	No time lost from work	51	35.7
	0-1 week lost from work	38	26.6
	1-2 weeks lost from work	9	6.3
	2-4 weeks lost from work	9	6.3
	More than 4 weeks lost from work	10	7.0
	Total	**143**	**100.0**

A number of surveys of self- reported work-related illnesses have been carried out by the Health and Safety Executive (2008) in the period of 2004/5 in Great Britain that reflected 11.6 million working days were lost through WRMSIs

caused by or made worse by work. On average, each person affected by occupational WRMSIs took an estimated 20.5 days off from work in the 12 month period.

Therefore, the time lost from work due to WRMSIs in the Durban Metropolitan Fire Department is lower than that found in the literature. However, it must be noted that due to the lack of research specific to WRMSIs in the fire service and the resultant absenteeism, comparison to the literature in this regard is limited.

4.5.4. OBJECTIVE FOUR: To determine whether selected factors are associated with the prevalence of WRMSIs.

4.5.4.1. General health

The majority of the firefighters who sustained WRMSIs (79.6%) felt that generally their health was good.

Table 4.12: General Health

		Injured				p value
		No		Yes		
		Count	%	Count	%	
How would you rate your general health?	Excellent	5	11.9%	37	88.1%	0.193
	Good	19	20.4%	74	79.6%	
	Moderate	3	37.5%	5	62.5%	
	Poor	0	.0%	0	.0%	

This question was included to evaluate the firefighters' perception of the impact of injury on his/her quality of life. This also would give an idea regarding the firefighters' health, fitness, stress-level and nutritional status. Seventy- four of the 93 fighters who felt that their health was "good" sustained WRMSIs.

4.5.4.2. Height

The firefighters fell mostly in the 1.5-1.75m height bracket.

Table 4.13. Height of the firefighters

		Injured				p value
		No		Yes		
		Count	%	Count	%	
What is your height?	1.5-1.75m	18	20.2%	71	79.8%	0.794
	1.75-2m	9	17.0%	44	83.0%	
	More than 2m	0	.0%	1	100.0%	

Height of the firefighters was not significantly related to the prevalence of WRMSIs. As most of the firefighters in this study fell between the 1.5-1.75 height bracket, this finding is consistent with the literature as Jayson (1996) established that individuals with an above average height (greater than 1.74m) have a greater propensity for developing low back pain than those of shorter stature. However, it must be noted that taller persons complain of low back pain predominantly due to incorrect postures they tend to adopt.

4.5.4.3. Weight

Most of the firefighters weighed between 76-95 kg. It was found that as weight increased up to 95kg, the risk of injury also increased. Thereafter, the risk decreased.

Table 4.14. Weight of the firefighters

		Injured				p value
		No		Yes		
		Count	%	Count	%	
What is your weight?	55-65 kg	5	35.7%	9	64.3%	***0.045***
	66-75 kg	8	22.9%	27	77.1%	
	76-85 kg	6	13.6%	38	86.4%	
	86-95 kg	4	10.0%	36	90.0%	
	96-110 kg	3	33.3%	6	66.7%	
	More than 110kg	1	100.0%	0	.0%	

This was not in compliance with the literature as Jayson (1996) found that people who are overweight are at greater risk for the development of low back pain, joint pain and muscular strain than those who are not overweight. Additionally, Pollack *et al.* (2008) found that the odds of injury were greater for obese workers compared to their leaner counterparts. This is possibly due to the trend seen in the emergency services as the more agile firefighters take on

more activities on the fireground than heavier firefighters (Bateman, 2007). A factor that can be considered is that while the weight of the firefighter may be less than 95kg, the added 20-25kg of the protective gear could be more of a burden to carry around during firefighting than it is for a sturdier firefighter who weighs more than 95kg. This increased weight on a smaller firefighter coupled with the increased exposure could be the reason for this inconsistent result.

Furthermore, as shown in Table 4.6 there is a tendency for increased injury the longer that a firefighter is in the service. This increased susceptibility to injury results in the firefighters moving further up the chain of command in the fire service, where they take up more administrative tasks and fewer fire ground activities. Thus the perception that could be created that injury rates actually decrease for those in the active fire service, similarly with the issues of weight, the decreased percentage of firefighters may not necessarily be related to their weight but rather to the fact that they are actually no longer part of the active fire service crew due to previous injury and were therefore excluded from this study.

Based on the above, there is a significant relationship between weight and the prevalence of WRMSIs in firefighters ($p < 0.005$).

4.5.4.4. Fitness training

The risk of injury increased as the frequency of training increased. Firefighters who sustained the largest percentage of injuries (85.7%) trained more than three times a week.

Table 4.15. Fitness training of the firefighters

		No		Yes		
		Count	**%**	**Count**	**%**	
On average, how often do you train per week?	0-1 times a week	5	50.0%	5	50.0%	**0.055**
	1-2 times a week	7	21.9%	25	78.1%	
	2-3 times a week	8	15.4%	44	84.6%	
	More than 3 times a week	7	14.3%	42	85.7%	
On average, how long do you train for in one session?	0-30 mins	4	28.6%	10	71.4%	0.121
	30 mins - 1 hour	14	18.4%	62	81.6%	
	1-2 hours	6	12.8%	41	87.2%	
	> 2 hours	3	50.0%	3	50.0%	
Do you do stretching exercises before training?	Yes	21	17.4%	100	82.6%	0.274
	No	6	27.3%	16	72.7%	
Do you have a warm-up session prior to training?	Yes	18	17.5%	85	82.5%	0.491
	No	9	22.5%	31	77.5%	
If you answered YES to Question 4, how long is your warm-up session?	0	8	22.9%	27	77.1%	0.909
	5 mins	9	17.3%	43	82.7%	
	10 mins	7	17.5%	33	82.5%	
	15 mins	2	15.4%	11	84.6%	
	>15 mins	1	33.3%	2	66.7%	
Do you perform or undertake strength training as part of your work out?	Yes	24	20.0%	96	80.0%	0.435
	No	3	13.0%	20	87.0%	
	Moderately aware and active	10	27.8%	26	72.2%	
	Lethargic and fairly aware	0	.0%	1	100.0%	

This is called the dose-response relationship as there is a direct proportional relationship between exposure and the predisposition to injury.

Those firefighters who performed stretching exercises and strength training had higher injury prevalence than those who did not (82.6% and 80% respectively). This finding did not conform to the literature as it was ascertained that physically fit individuals can adapt to increased biomechanical loads, resulting

in decreased susceptibility to injury (Louhevaara, 1984; Sothemann *et al.*, 1992; Lusa, 1994). This finding could however, be attributed the trend that the more agile firefighters take on more activities on the fireground than those who are not. Moreover, a high degree of injuries in the fire service are beyond human control and could be a contributing factor in the lack of correlation with these findings and that of the reviewed literature.

It is also possible that tissue fatigue or minor injuries during fitness training as using the tissues continuously or for long periods result in the body being unable to keep up with repair to the damaged tissue (Putz-Anderson, 1992). These injuries or tissue fatigue could be brought into the work place and be translated into an occupational injury or be exacerbated by occupational activities.

4.5.4.5. Occupational stress

The firefighters' perception of their stress levels did not yield any statistical significance with regards to the prevalence of WRMSIs.

Table 4.16. Occupational stress risk factors for injury- firefighter perception

		No		Yes		
		Count	%	Count	%	
How would you rate your stress levels generally?	High	4	17.4%	19	82.6%	0.797
	Moderate	17	20.7%	65	79.3%	
	Low	6	15.8%	32	84.2%	
How would you describe your sleeping patterns?	Very good, regular	7	23.3%	23	76.7%	0.363
	Satisfactory	14	23.7%	45	76.3%	
	Disturbed	3	8.1%	34	91.9%	
	Difficulty falling asleep	3	18.8%	13	81.3%	
	Don't sleep at all	0	.0%	1	100.0%	
How would you describe yourself in the working environment?	Alert and energetic	15	15.5%	82	84.5%	0.408
	Moderately aware and active	10	27.8%	26	72.2%	
	Lethargic and fairly aware	0	.0%	1	100.0%	

The following stress-related symptoms and illnesses were significantly associated with current injury: nightmares (p=0.030), agitation (p=0.001), alcohol consumption (p=0.031), headaches (p= 0.045), loss of appetite (p=0.028), muscle stiffness (p=0.023), and heart burn (p=0.048).

Table 4.17. Occupational stress risk factors for injury- stress-related symptoms and illnesses

		Injury				P value
		Yes		No		
		Count	%	Count	%	
Nightmares	No	43	31.6%	93	68.4%	***0.030***
	Yes	5	71.4%	2	28.6%	
Fear	No	46	32.9%	94	67.1%	0.261
	Yes	2	66.7%	1	33.3%	
Hallucination	No	46	32.9%	94	67.1%	0.261
	Yes	2	66.7%	1	33.3%	
Withdrawal	No	44	34.6%	83	65.4%	0.441
	Yes	4	25.0%	12	75.0%	
Poor concentration	No	43	33.3%	86	66.7%	0.858
	Yes	5	35.7%	9	64.3%	
Agitation	No	35	28.2%	89	71.8%	***0.001***
	Yes	13	68.4%	6	31.6%	
Alcohol consumption	No	41	30.8%	92	69.2%	***0.031***
	Yes	7	70.0%	3	30.0%	
Palpitations	No	46	33.3%	92	66.7%	0.756
	Yes	2	40.0%	3	60.0%	
Weakness	No	46	33.8%	90	66.2%	0.774
	Yes	2	28.6%	5	71.4%	
Hyper vigilance	No	47	33.3%	94	66.7%	1.000
	Yes	1	50.0%	1	50.0%	
Headaches	No	31	29.0%	76	71.0%	***0.045***
	Yes	17	47.2%	19	52.8%	
Profuse sweating	No	44	33.1%	89	66.9%	0.655
	Yes	4	40.0%	6	60.0%	
Loss of appetite	No	41	31.1%	91	68.9%	***0.028***
	Yes	7	63.6%	4	36.4%	
High blood pressure	No	39	30.7%	88	69.3%	***0.041***
	Yes	9	56.3%	7	43.8%	
Migraine	No	42	32.6%	87	67.4%	0.438
	Yes	6	42.9%	8	57.1%	
Muscle Stiffness	No	20	25.6%	58	74.4%	***0.023***
	Yes	28	43.8%	36	56.3%	
Depression	No	43	32.6%	89	67.4%	0.385

	Yes	5	45.5%	6	54.5%	
Ulcers	No	47	34.3%	90	65.7%	0.664
	Yes	1	16.7%	5	83.3%	
Heart burn	No	33	29.5%	79	70.5%	***0.048***
	Yes	15	48.4%	16	51.6%	
Stroke	No	48	33.6%	95	66.4%	-
	Yes	0	.0%	0	.0%	
Heart attack	No	48	34.0%	93	66.0%	0.551
	Yes	0	.0%	2	100.0%	
Other heart conditions	No	48	33.8%	94	66.2%	1.000
	Yes	0	.0%	1	100.0%	
Eczema	No	48	34.0%	93	66.0%	0.551
	Yes	0	.0%	2	100.0%	
Low back pain	No	13	28.3%	33	71.7%	0.355
	Yes	35	36.1%	62	63.9%	
Hair loss	No	48	34.8%	90	65.2%	0.168
	Yes	0	.0%	5	100.0%	

As discussed in Chapter Two, firefighters are known to contain or deny the extent of their stress levels due to the public's expectation of bravery from them (Delsohn, 1996). It was therefore decided to include a table of stress-related symptoms and illnesses in the questionnaire in order to gauge the stress levels of the firefighters (Marmar *et al.,* 1996; Haslett *et al.,* 2002). In Part C of the questionnaire (Appendix K), firefighters were asked to rate their stress level as high, moderate or low. 82.6% of the firefighters who rated their stress level as high, sustained injuries. The majority of the sample (45.5%) rated their stress levels as moderate.

Participants were then questioned regarding their sleep patterns, demeanour at work and the presence of any stress-related symptoms or illnesses. Forty five of the 116 injured firefighters reported that their sleep was satisfactory and 34 reported disturbed sleep. The majority of the firefighters (107) reported that they were "alert and energetic" while 36 stated that they were "moderately aware and active."

Based on this self-perception of stress levels by the firefighters, the statistics yielded no significance to the prevalence of WRMSIs.

However, when the prevalence of stress-related symptoms and illnesses was statistically evaluated, this study found that nightmares (p=0.030), agitation (p=0.001), alcohol consumption (p=0.031), headaches (p= 0.045), loss of appetite (p=0.028), muscle stiffness (p=0.023), and heart burn (p=0.048), were all significantly associated with current injury. This study thus concluded that there is a significant relationship between stress and the prevalence of WRMSIs.

This did corroborate with the reviewed literature (Andersson, 1999; Kirkaldy-Willis and Bernard, 1999; Devereux *et al.,* 1999; Davis and Heaney, 2000). Devereux *et al.* (2004) described how sustained stress responses may result in increased muscle co-activation and thus increased loading on the musculoskeletal system. Additionally, perceived job stress may impede the ability of the musculoskeletal system to recover during or after work. Moreover, central nervous system responses to perceived job stress may increase sensitization to pain stimuli (Rydstedt, 2003). Furthermore, Jones *et al*. (2007) found that mechanical loading, postural factors, psychological distress, and workplace psychosocial factors were risk factors for new onset knee pain during the 2-year follow-up period. This is consistent with the results of this study as knee injuries constituted for 22.5% of the injuries sustained.

These stress-related symptoms and illness could also be as a result of training patterns and marital problems. As shown in Table 4.3, there is an increased rate of divorce and separation in the sample of firefighters. Hildebrand (1984), Blum (1994) and Oosthuizen (2004) who found an increased frequency of divorce and marital problems among firefighters due to the psychological stress associated with the occupation and are associated with psychiatric, alcohol and drug abuse problems. Furthermore, Table 4.15 shows that firefighters who

sustained the largest percentage of injuries (85.7%) trained more than three times a week. This can be attributed to tissue fatigue causing muscle stiffness (Putz-Anderson, 1992).

4.5.4.6. Smoking

Forty six of the firefighters in the sample were smokers and 24 were ex-smokers. Of these, 35 firefighters sustained WRMSIs. The average number of cigarettes smoked was 6-10 a day.

Table 4.18: Smoking and the risk of injury

		Injured				p value
		No		Yes		
		Count	%	Count	%	
Are you a smoker?	Yes	11	23.9%	35	76.1%	0.317
	No	16	16.8%	79	83.2%	
If yes, on average how many cigarettes do you smoke a day	1-5	4	28.6%	10	71.4%	0.238
	6-10	2	10.5%	17	89.5%	
	11-15	2	28.6%	5	71.4%	
	16-20	2	28.6%	5	71.4%	
	>20	1	100.0%	0	.0%	
Do you have a previous history of smoking but have now stopped?	Yes	3	12.5%	21	87.5%	0.543
	No	13	17.8%	60	82.2%	
If YES to 8) above: How many cigarettes did you smoke per day?	1-5	0	.0%	6	100.0%	0.140
	6-10	1	9.1%	10	90.9%	
	11-15	2	50.0%	2	50.0%	
	16-20	0	.0%	3	100.0%	
	>20	0	.0%	1	100.0%	
How many years did you smoke for?	1-2	0	.0%	8	100.0%	0.559
	3-4	1	14.3%	6	85.7%	
	5-6	1	20.0%	4	80.0%	
	7-8	0	.0%	2	100.0%	
	>=9	1	33.3%	2	66.7%	
How many years have you stopped smoking for?	0-2	2	25.0%	6	75.0%	0.518
	3-5	1	10.0%	9	90.0%	
	6-8	0	.0%	3	100.0%	
	>8 years	0	.0%	4	100.0%	
	No	14	15.7%	75	84.3%	

When statistically tested, the results did not yield a correlation between smoking and the prevalence of WRMSIs which did not correspond with the literature (Boshuizen *et al.,* 1992; Leino-Arjas, 1998; Palmer *et al.*, 2003). As previously mentioned, smokers report a higher frequency of injuries and illness, are less physically active and have a lower level of physical fitness than non-smokers (Gardner, 2000).

4.5.4.7. Protective gear

Seventy nine of the 116 injured firefighters felt their gear had a satisfactory fit. The majority of the sample (120 firefighters) felt that their posture and movement was hindered by their gear. Of these 120 firefighters, 97 sustained WRMSIs.

Table 4.19. Protective gear and the risk of injury

		Injured				p value
		No		Yes		
		Count	%	Count	%	
Helmet		27	19.0%	115	81.0%	1.000
Nomex/PBI hood		21	18.9%	90	81.1%	1.000
SCBA respirator face piece		26	21.1%	97	78.9%	0.123
SCBA harness		24	19.8%	97	80.2%	0.494
Turnout coat		27	19.1%	114	80.9%	1.000
Turnout pants		27	19.3%	113	80.7%	1.000
Boots		26	18.4%	115	81.6%	1.000
Gloves		27	19.0%	115	81.0%	1.000
Non SCBA respirator		0	.0%	12	100.0%	0.123
Fatigues		22	19.8%	89	80.2%	0.593
How comfortable are you in your protective gear?	Yes, excellent fit	5	17.9%	23	82.1%	0.974
	Satisfactory fit	19	19.4%	79	80.6%	
	Poor fit	3	17.6%	14	82.4%	
Do you feel that your posture or movement is sometimes hindered by your gear during fire fighting?	Yes	23	19.2%	97	80.8%	0.842
	No	4	17.4%	19	82.6%	

An open-ended question was included to allow the firefighters to elaborate as to how their gear hinders their performance. The most common complaints are tabulated below, together with the number of responses.

Table 4.20. Firefighter responses-problems with protective gear

Problems with protective gear	No. of responses
Too heavy with SCBA, more especially when wet.	51
Restricts movement for maximum performance, especially running	53
Cannot bend properly, especially during lifting tasks	15
The sizes available do not suit my size.	44
Straps on bunker pants too tight, pull down on shoulders	18
Difficult to manipulate objects with gloves	17
Too bulky, difficult to run, climb and bend, especially during lifting tasks.	48
Poor vision with SCBA mask.	9
Boots very uncomfortable and cause painful chafing	14

As illustrated above, the findings of this study are consistent with the literature that firefighter gear is too heavy, too bulky and restricts movement (Louhevaara, 1984; Gilman and Davis, 1993; Rose, 1996; Donovan and McConnell, 1998, Havenith and Heus, 2004). The foremost complaint was the weight of the SCBA which is carried in a harness on the firefighters back. Furthermore, the firefighters reported that the gear was not tailored to their size and the restricted movement hindered their performance. Some found that the bunker coats were too long and that they had to lift the coat every time they had to climb. Eighteen firefighters felt that straps that hold up their bunker pants were too tight and pulled down on their shoulders, no matter how they adjusted them. Firefighters felt that the bulkiness of the pants made it difficult to run, climb and bend as the fabric of the gear was not pliable. The high rate of knee injuries found in this study could be attributed to this. While the statistics in this

study yielded no correlation between the comfort and fit of protective gear and the prevalence of WRMSIs, the feedback from the firefighters does indicate that there is room for improvement with regards to individual sizes, fit and design of firefighter PPE. This would perhaps decrease the musculoskeletal load on the firefighters, but may not significantly address more significantly perceived stressors.

4.5.4.8. Injury prevention advice

The only significant factor associated with injury was whether they had been given nutritional advice (p=0.006). Those who had been given little advice were less at risk for injury than those who had been given some or no advice

Table 4.21. Injury prevention advice and the risk of injury

		Injured				***p value***
		No		***Yes***		
		Count	***%***	***Count***	***%***	
Are you given advice regarding correct working postures?	Some	21	19.3%	88	80.7%	0.376
	Little	4	13.8%	25	86.2%	
	None	2	40.0%	3	60.0%	
Are you given advice regarding correct lifting techniques to protect your lower back?	Some	22	18.5%	97	81.5%	0.526
	Little	4	18.2%	18	81.8%	
	None	1	50.0%	1	50.0%	
Are you given nutritional advice on what to eat and drink?	Some	4	12.9%	27	87.1%	***0.006***
	Little	12	38.7%	19	61.3%	
	None	11	13.6%	70	86.4%	
Do you utilise the advice regarding injury prevention provided by the training officer at all times?	All the time	18	20.5%	70	79.5%	0.707
	Sometimes	8	17.8%	37	82.2%	
	Never	1	10.0%	9	90.0%	
Do you feel that you have been given sufficient training advice regarding the prevention of musculoskeletal injuries?	Yes	13	24.1%	41	75.9%	0.216
	No	14	15.7%	75	84.3%	

The final part of the questionnaire evaluated the injury prevention advice that was given to the firefighters. Eighty percent of the firefighters reported that they received “some” advice regarding correct lifting techniques and working postures sustained WRMSIs. This was perplexing as the most prevalent injuries were to the low back caused by lifting heavy objects (55.4%) and working in awkward positions (44.6%). However, 79.5% of those firefighters who reported that they utilize the injury prevention given to them “all the time” sustained injuries.

The majority of the firefighters reported they were given no nutritional advice (79.5%). This was found to be statistically significant in the prevalence of WRMSIs (p= 0.006). It was found that those firefighters who were given little advice were less at risk than those who were given some or no advice regarding nutrition. The significance of agitation, headaches and heartburn associated with injury (Table 4.17) could also be of significance nutritionally as these symptoms are also related to gastrointestinal health (Haslett *et al.,* 2002).

As previously discussed, hydration is an important part of nutrition as dehydration of as little as 2% can affect physical performance, which can result in injury (Gieck, 2004). Nutritious food, with an increased carbohydrate intake, fuels the muscles for hard work (Gieck, 2004; Maughan, 2000), which is essential as a firefighter can burn between 5000-6000 calories a day (NWCG, 2004). It is important to replace these calories to prevent fatigue, cramping and judgment impairment. Therefore, nutritional advice is essential for a firefighter for optimal performance and injury prevention.

Eighty nine firefighters in the sample felt that they were not given sufficient advice to prevent WRMSIs in their working environment.

This study thus concludes that firefighters in the Durban Metropolitan Fire Department are not given sufficient injury prevention advice, nutritional advice

and psychological support. Recommendation in this regard will follow later in the chapter.

4.5.5. OBJECTIVE FIVE: To assess the strength of the relationships of *selected factors* with the most common injuries presented in the results.

4.5.5.1. Risk factors for low back injuries

Previous smokers were significantly more likely to injure their lower back than those who were not previous smokers (p=0.011). No other risk factors were significantly associated with low back injury.

Table 4.22: Risk factors for low back injuries

		Count	%	P value
How would you rate your stress levels generally?	High	12	52.2%	0.598
	Moderate	36	43.9%	
	Low	20	52.6%	
How would you describe your sleeping patterns?	Very good, regular	14	46.7%	0.828
	Satisfactory	27	45.8%	
	Disturbed	19	51.4%	
	Difficulty falling asleep	7	43.8%	
	Don't sleep at all	1	100.0%	
Alcohol consumption	No	62	46.6%	0.518
	Yes	6	60.0%	
Are you a smoker?	Yes	25	54.3%	0.212
	No	41	43.2%	
Do you have a previous history of smoking but have now stopped?	Yes	16	66.7%	***0.011***
	No	27	37.0%	

This finding is consistent with the study by Altarac *et al.* (2000) who concluded that the detrimental effects of smoking persist for several weeks after the cessation of smoking. This finding is of great significance to the administrators of the fire service as smoking can interfere with injury risk of a firefighter.

4.5.5.2. Risk factors for shoulder injuries

Alcohol consumption was significantly associated with shoulder injury (p=0.025).

Table 4.23: Risk factors for shoulder injuries

		Shoulder				
		No		Yes		
		Count	Row N %	Count	Row N %	P value
How would you rate your stress levels generally?	High	18	78.3%	5	21.7%	0.951
	Moderate	66	80.5%	16	19.5%	
	Low	31	81.6%	7	18.4%	
How would you describe your sleeping patterns?	Very good, regular	25	83.3%	5	16.7%	0.281
	Satisfactory	49	83.1%	10	16.9%	
	Disturbed	28	75.7%	9	24.3%	
	Difficulty falling asleep	13	81.3%	3	18.8%	
	Don't sleep at all	0	.0%	1	100.0%	
Alcohol consumption	No	110	82.7%	23	17.3%	***0.025***
	Yes	5	50.0%	5	50.0%	
Are you a smoker?	Yes	40	87.0%	6	13.0%	0.158
	No	73	76.8%	22	23.2%	
Do you have a previous history of smoking but have now stopped?	Yes	20	83.3%	4	16.7%	0.417
	No	55	75.3%	18		

This could be due to the negative effect of alcohol on skeletal muscle, causing skeletal muscle myopathy as proposed by Slavin *et al.,* (1983), Preedy and Peters (1988), Urbano Marquez *et al*. (1989) and Reilly *et al.* (2000). Urbano Marquez *et al*. (1989) found that heavy alcohol consumption damages the heart muscle in one third of the subjects, and skeletal muscles in half of them. In addition, muscle weakness is proportional to the amount of alcohol consumed; however, this myopathy is reversible if alcohol consumption stops (Slavin *et al.,* 1983).

4.5.5.3. Risk factors for knee injuries

High stress was associated significantly with knee injury (p=0.035). Disturbed and difficult sleep was also a significant risk factor of knee injury (p=0.038).

Table 4.24: Risk factors for knee injuries

		Count	%	P value
How would you rate your stress levels generally?	High	8	34.8%	***0.035***
	Moderate	12	14.6%	
	Low	12	31.6%	
How would you describe your sleeping patterns?	Very good, regular	7	23.3%	***0.038***
	Satisfactory	7	11.9%	
	Disturbed	12	32.4%	
	Difficulty falling asleep	5	31.3%	
	Don't sleep at all	1	100.0%	
Alcohol consumption	No	30	22.6%	1.000
	Yes	2	20.0%	
Are you a smoker?	Yes	12	26.1%	0.503
	No	20	21.1%	
Do you have a previous history of smoking but have now stopped?	Yes	5	20.8%	0.911
	No	16	21.9%	
	Yes	24	21.6%	

This is consistent with the study by Jones *et al*. (2007) who found that mechanical loading, postural factors, psychological distress, and workplace psychosocial factors were risk factors for knee pain. It is also possible that the disrupted sleep may be a consequence of a knee injury and not vice versa.

4.5.5.4. Risk factors for ankle injuries

Table 4.24: Risk factors for ankle injuries

		Ankle injuries		P value
		Count	%	
How would you rate your stress levels generally?	High	5	21.7%	0.553
	Moderate	13	15.9%	
	Low	9	23.7%	
How would you describe your sleeping patterns?	Very good, regular	5	16.7%	0.656
	Satisfactory	9	15.3%	
	Disturbed	10	27.0%	
	Difficulty falling asleep	3	18.8%	
	Don't sleep at all	0	.0%	
Alcohol consumption	No	23	17.3%	0.077
	Yes	4	40.0%	
Are you a smoker?	Yes	6	13.0%	0.200
	No	21	22.1%	
Do you have a previous history of smoking but have now stopped?	Yes	3	12.5%	0.257
	No	17	23.3%	

No associations were found between the above factors and ankle injuries.

4.6. OBJECTIVE SIX: To recommend preventative measures based on the results and the reviewed literature.

Under the Occupational Health and Safety Act (OHSA) of South Africa 85 of 1993, every employer has the following responsibilities:

> "To provide for the health and safety of persons at work and for the health and safety of persons in connection with the use of plant and machinery: the protection of persons at work against hazards to health and safety arising out of or in connection with the activities of persons at work: to establish an advisory council for occupational health and safety: and to provide for matters connected therewith."

This study has concluded that the prevalence of WRMSIs among the firefighters in the Durban Metropolitan Fire Department is substantial and suggests that workplace efforts directed towards the primary prevention of WRMSIs can be effective if they focus on the risk factors highlighted in this study.

4.6.1. Recommendations to the Durban Metropolitan Fire Department.

The following are recommendations to the Durban Metropolitan Fire Department that were considered after evaluation of the results.

4.6.1.1. *Reduce WRMSIs by implementation and reiteration of nutritional advice and correct working postures.*

While 80% of the firefighters in this study reported that they received "some" advice regarding correct lifting techniques and working postures, this study found that almost 50% of all WRMSIs sustained by the firefighters in the three year period was to the low back. This requires training officers to re-visit this area of the course structure in order to decrease the prevalence of these injuries.

In addition to incorrect lifting, this study found that a substantial contribution to the prevalence of WRMSIs was derived from working in awkward postures. This employs any of the movements illustrated in the Figure. 2.1 in Chapter two.

Nutritional advice is imperative to prevent injury (Gieck, 2004). Nutritious food is not only a morale booster but also fuels the muscles for hard work as firefighters can burn 5000 to 6000 calories a day. It is important to replace these calories to prevent fatigue, cramping and judgment impairment. Firefighter diets should be low in fats, high in protein and complex carbohydrates (NWCG, 2004).

Hydration is an important part of nutrition as dehydration of as little as 2% can affect physical performance, which can result in injury (Gieck, 2004). Water is an excellent for replacing fluid loss and natural juices contain energy-restoring glucose. Caffeinated and carbonated drinks should be avoided (NWCG, 2004).

4.6.1.2. *Reduce WRMSIs by ensuring that firefighters have gear that have a proper fit and consider implementing lighter-weight self-protective equipment such as Self-Contained Breathing Apparatus.*

The main problem highlighted in this study with regards to the firefighter gear was that the weight of the gear impedes movement. When wet, the weight of the gear increases significantly. Presently, the Durban Metropolitan Fire Department utilizes SCBA's with high-profile cylinders. The total unit weighs approximately 16 kg. Currently, newer technology is available, such as commercially available SCBA's that are equipped with a 30-minute carbon cylinder, weigh 9kg. The use of a lighter- weight SCBA would:

- Reduce physical stress on the firefighter, thereby decreasing the impediment during movement.

- Provide better physical clearance for firefighters in close situations

- Reduce the need to conduct some fireground activities without the use of a SCBA, thereby reducing the exposure of firefighters to the products of combustion and hence injury (Manning and Griggs, 1983; Louhevaara, 1984; White and Hodus, 1987; Sykes, 1993; Donavan and McConnell, 1998).

Additionally, some firefighters reported that their gear was not tailored to their size and that the available sizes did not suit them. For example, it was reported that even though a firefighter wore a large bunker coat, it was too long for his height. Therefore, whenever he had to climb or walk uphill, he had to lift his bunker coat in order to flex his hip and knee properly. This can be particularly cumbersome in certain situations, e.g. carrying equipment up stairs or uphill.
Other firefighters reported that their helmets were too big and some reported that even the smallest size of the bunker coat and pants were too big. The high prevalence of injuries found in this study is something that needs to be seriously considered. The working environment of a firefighter is hazardous enough and discomfort in their gear further increases their risk of injury.

With regards to fitness, individualized assessment and exercise routines can be provided with periodic re-evaluation to make any necessary adjustments.

4.6.1.3. *Reduce risk factors for WRMSI by implementing a wellness and fitness program for firefighters.*

As previously stated, injury prevention has been determined to be more cost-effective than treating chronic injuries (Rodgers, 2007; OOSHA, 2007).The development of a wellness and fitness program with the goal of reducing injuries in the fire service can be beneficial. Health promotion and advice regarding lifestyle factors and fitness can be reviewed. The first step is to ensure that all firefighters understand what WRMSIs are and what are their

symptoms and signs. It may also be helpful to incorporate WRMSI prevention activities during training as this study found that there is a risk of 19.6% of injuries occurring during training per annum.

This study found a significant relationship between ex-smoking and low back injuries as well as alcohol consumption and shoulder injuries. In the sample of this study, 46 firefighters were smokers and 24 were ex-smokers. Therefore, based on the results of this study, smoking is a comprehensive risk factor for WRMSIs in the fire service.

The chance of quitting smoking alone is only about 5% (Weil, 2003). Good social support, behavioral counseling and a role model who has successfully quit smoking have all proven to be essential when attempting to quit (Law and Tang, 1995). This should be possible in the Department as there are many ex-smokers in the fire service. Additionally, the use of the anti-depressant Zyban (bupropion SR) has been shown to be beneficial, though the reasons for this are not understood (Law and Tang, 1995; Weil, 2003). This, however, must only be used under the advice of a medical practitioner. Other alternatives include nicotine patches, gum and candy. However, it has been found that people who quit “cold turkey” have the highest success rate (Weil, 2003).

Therefore advice on physical conditioning, diet and nutrition together can be beneficial (Rose, 1996). In addition, advising firefighters on strengthening their core muscles to protect their low back can help reduce back injuries. Findings suggest that core strength and functional movement enhancement programs to prevent injuries in workers whose work involves awkward positions is warranted (Leetun *et al.,* 2004; Willson *et al*., 2005).

Blum (1994) suggests that fire departments develop wellness technologies that incorporate those components of firefighting that are known to create, maintain or reduce problematic work performance circumstances and / or stress

reactions in firefighters. Shantz (2002) found that certain personality types did not cope well with psychological stress but did cope better with proper education, training and counseling. Outlets for de-briefing and counseling can be beneficial when dealing with stress. Furthermore, the effect of stress caused by or made worse by marital and relationship problems can also be addressed in these sessions. The majority of the fire stations are located within close proximity of hospitals who can offer this service. This could substantially reduce the incidence of post-traumatic stress experienced by firefighters.

Education and awareness of potential health inducing and health problems is essential if most individuals are to enjoy a 25-30 year career (Shantz, 2002). Strategies that promote a holistic view supporting a balance of all activities may be more effective in reducing injury prevalence.

Utilizing these recommendations suggested after review of the literature and the results of this study will most likely depend on available resources of the Durban Metropolitan Fire Department. These suggestions can be reviewed by the Fire Department to identify elements that would be feasible and effective in their situation.

4.7. CONCLUSION

By examining the prevalence of WRMSIs, it is possible to focus on risk factors that bring about their onset. Evaluation of the data revealed that firefighters are vulnerable to injuries of the low back, knee, shoulder and ankle. This was largely due to heavy lifting, running and working in awkward postures. Statistical analysis of the selected risk factors in this study established a link between:

- **Marital status**[1]
- Selected *race groups*[2] and the prevalence of WRMSIs
- ***History of smoking*** and the risk of low back injuries
- ***Stress*** and the prevalence of WRMSIs
- **Stress** and the risk of knee injuries
- **Alcohol consumption** and the risk of shoulder injuries
- Amount of ***nutritional advice*** [3] given and the prevalence of WRMSIs

However, it must be noted that these findings are guarded with respect to the limitations of this study discussed in Chapter One. We cannot infer causality due to the cross-sectional design of this study. For example, the association between stress and knee injuries may not mean that if a firefighter is experiencing a stress reaction that he will sustain a knee injury. Instead, it may mean that a firefighter is experiencing high levels of stress *because* he has a knee injury that is affecting his performance. Furthermore, this study did not take into account any pre-existing medical conditions that the firefighters may have that could predispose them to injury.

This is particularly pertinent as it would seem that the themes that have consistently been found in this study actually seem to related more consistently with non WRMSIs indicated in the bullets above and therefore future research should look to establish the degree to which work, psychosocial, cultural and personal factors influence the injuries that have to date been reported as work related.

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[1] It would seem that there is a possibility for further investigation of these factors (**bold**) in terms of their likelihood of association and contribution to the high injury rate that firefighters sustain, in order to reduce the effect these factors seem to have (based on the trends seen in the results of this research).
[2] It would seem that there is a possibility for further investigation of these factors (***italics***) in terms of their likelihood of association and contribution to the high injury rate that firefighters sustain, in order to reduce the effect these factors seem to have (based on the trends seen in the results of this research).
[3] It would seem that there is a possibility for further investigation of these factors (***italics***) in terms of their likelihood of association and contribution to the high injury rate that firefighters sustain, in order to reduce the effect these factors seem to have (based on the trends seen in the results of this research).

CHAPTER FIVE: RECOMMENDATIONS

6.1. INTRODUCTION

WRMSIs are a serious occupational problem accounting for at least one-third of all work-related injuries in the United States (Dong-Chui and Blair, 2003) and are the most common injuries among firefighters, accounting for 50% of injuries sustained by firefighters in the United States (Conrad *et al*., 1994).

6.2. RECOMMENDATIONS FOR FUTURE STUDIES

- ✓ For improved results, this study can be performed in other Fire Departments in other South African cities to illicit more information regarding the prevalence and risk factors for WRMSIs among firefighters.
- ✓ Further investigation can be done utilizing the results of this study to determine the strength and mechanisms of specific factors highlighted. For example, the prevalence of low back injuries in this study was high (47.9%). Firefighters reported they were given very little or no nutritional advice. A dietary evaluation can be done to determine the relationship between nutrition and injuries to the low back in firefighters.
- ✓ The results of this study found a significant relationship between shoulder injuries and alcohol consumption. This study did not ascertain the frequency and amount of alcohol consumed by firefighters. Future studies should investigate this risk factor in more detail.
- ✓ A prospective study regarding the same factors investigated in this study conducted after implementation of any preventative measures would provide more accuracy of the results highlighted in this study.
- ✓ Marital dysfunction and divorce were highlighted in this study as important stressors in firefighters. This area requires further research to determine the extent to which marital dysfunction impacts on firefighters.

- ✓ The association between selected race groups and the prevalence of injuries has been highlighted in this study as well as previous studies (Docrat, 1999; Vlok, 2005). While this finding has been affirmed, the significance of this relationship has not been determined. Thus, further research is required.

6.4. CONCLUSION

This study has presented evidence that demographical, biomechanical and psychosocial risk factors are associated with WRMSIs in the fire service. While some circumstances that lead to firefighter injuries are simply beyond human control, through research into causative and risk factors, development of new technologies, improvement of protective gear training and education, it should be possible to significantly reduce the number of injuries sustained by firefighters each year. Moreover, firefighter injuries are generally the result of a chain of events, which, if recognized, may be broken to prevent a majority of injuries.

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APPENDIX A – LETTER OF PERMISSION

DURBAN UNIVERSITY of TECHNOLOGY

The Durban Metropolitan Fire Department
15 Centenary Rd
Durban
4000

29 January 2008

Dear Sir/ Madam

Re: Permission to conduct research study

I am a student enrolled at the Chiropractic (Masters) program at the Durban University of Technology (DUT). As part of my Masters qualification I am required to conduct a research study. The title of my study is:

An investigation into the prevalence and risk factors of occupational musculoskeletal injuries in firefighters in the Durban Metropolitan Fire Department.

The aim of this study is to outline:

- the most common musculoskeletal injuries sustained by firefighters
- The risk factors associated with injuries
- To recommend preventative measures which may be helpful in the reduction of injury incidence.

It is hoped that the results of this study will contribute to the formation of effective injury prevention programs and safety guidelines thereby ensuring improved occupational health and safety. It is a questionnaire based study so will not interfere in any way with work at the stations.

I kindly request your permission and help to conduct this study. Participation in this study will be voluntary and anonymous and the information gathered will be treated with respect and confidentiality. The results of this study will be made available to the Department and the participants in the form of a mini-dissertation in the University library.

Please contact me if you have any queries/concerns.
Sincerely,

_____

Researcher : Ms. D. Albert (031 3732512)

SUPERVISOR : Dr. N. Gomes (MTECH CHIROPRACTIC, C.C.S.P. MMedSc(Sports Medicine)

CO-SUPERVISOR : Dr. C. Korporaal (MTECH: CHIROPRACTIC. CCFC, CCSP, ICSSD)

APPENDIX B – LETTER OF CONSENT

ETHEKWINI MUNICIPALITY
Fire & Disaster Management

18 Centenary Road
Durban
4001
PO Box 625
Durban
4000
Tel: [27 31] 308-7000
Fax: [27 31] 309-1050
e-mail : dbnfire@iafrica.com

To	:	Ms D Albert
From	:	Manager : Operations
Date	:	29 January 2008
Subject	:	PERMISSION TO CONDUCT RESEARCH STUDY

Your letter dated 28 January 2008 refers.

Thank you for your enquiry.

This serves to confirm permission to conduct research studies at Durban Metro Fire Stations, provided that does not interfere with their station activities and that a department indemnity form is completed by yourself.

We look forward to assisting your studies.

_____
PE MCHUNU
MANAGER: OPERATIONS
ETHEKWINI FIRE & DISASTER MANAGEMENT

APPENDIX C- LETTER ON INFORMATION- FOCUS GROUP

LETTER OF INFORMATION

Dear Participant,

I would like to welcome you into the focus group of my study.

The title of my research project is:

The prevalence and risk factors of occupational musculoskeletal injuries in firefighters in the Durban Metropolitan Fire Department.

Background to the study:

The firefighting service is one of the most hazardous occupations, with the rate of injury, illness and fatality higher than most occupations. Due to working in harsh and dynamic environments, firefighters face an increased risk of injury, including musculoskeletal injury. The Health and Safety Executive in the United Kingdom defines musculoskeletal injuries as problems affecting the muscles, tendons, ligaments and nerves or other soft tissues and joints. The back, neck and upper limb are particularly at risk.

Musculoskeletal injuries can be debilitating and be a risk for further injuries for firefighters on the fire ground. The literature on the cause of the injuries is sparse but has been determined to be largely ergonomic in nature.

Some activities that have been identified as risk factors for injuries include operating charged hose, breaking windows, cutting structures, climbing ladders and lifting objects more than 18kg.

The aim of this study is to determine the most common injuries sustained, how they where caused, the risk factors associated with these injuries and what treatment was obtained.

The results of this study will focus on the first two stages of the injury prevention process i.e. identifying and describing the extent of the injury and identifying and describing factors and mechanisms that play a part in the occurrence of injuries.

The reason for holding the focus group is to stimulate individuals thinking and encourage them to develop ideas about the topic (Salant and Dillman, 1994). Focus groups also encourage individuals other than those doing the research to support the research process by increasing research relevance (Salant and Dillman, 1994).

In order to understand the outcomes required for the focus group it is important to understand the objectives set out for this study:

- Objective 1: To identify the anatomical sites, nature and etiology of musculoskeletal injuries sustained by the firefighters.

- Objective 2: To determine what treatment was obtained.
- Objective 3: To determine the risk factors associated with injury.
- Objective 4: To determine preventative measures which might help reduce the incidence of injuries.

Therefore the research would require you as members of the focus group to assist in identifying as many pertinent factors as possible as a result of your participation or association with the programme.

Your participation in this study is much appreciated and you are assured that your comments and contributions to the discussion will be kept confidential. The results of the discussion will only be used for research purposes.
If you have any further questions please feel free to contact me.

Dhimunthree Albert (031 3732512)

APPENDIX D- CODE OF CONDUCT: FOCUS GROUP

CODE OF CONDUCT

This form needs to be completed by every member of the Focus Group prior to the commencement of the focus group meeting.

As a member of this committee I agree to abide by the following conditions:

1. All information contained in the research documents and any information discussed during the focus group meeting will be kept private and confidential. This is especially binding to any information that may identify any of the participants in the research process.

2. Due respect to be given to every suggestion and comment by any member of the focus group and be debated with reference to the outcomes of the research.

3. The information gathered from this focus group by the researcher will be made public in terms of a mini dissertation and journal publication. The researcher will ensure that any participants in the focus group and research remain anonymous and confidential.

Member represents	Member's Name	Signature	Contact Details

APPENDIX E- INFORMED CONSENT FORM: FOCUS GROUP

INFORMED CONSENT FORM

(TO BE COMPLETED BY THE PARTICIPANTS OF THE FOCUS GROUP)

DATE:

TITLE OF RESEARCH PROJECT:

The prevalence and risk factors of occupational musculoskeletal injuries in the Durban Metropolitan Fire Department.

NAME OF SUPERVISOR AND CO- SUPERVISOR:
Dr. Neil Gomes (0824399027), Dr C. Korporaal (0832463562)

NAME OF RESEARCH STUDENT:
Dhimunthree Albert (031 3732512)

Please circle the appropriate answer	**YES /NO**	
1. Have you read the research information sheet?	Yes	No
2. Have you had an opportunity to ask questions regarding this study?	Yes	No
3. Have you received satisfactory answers to your questions?	Yes	No
4. Have you had an opportunity to discuss this study?	Yes	No
5. Have you received enough information about this study?	Yes	No
6. Do you understand the implications of your involvement in this study?	Yes	No
7. Do you understand that you are free to		
a) Withdraw from this study at any time?	Yes	No
b) Withdraw from the study at any time, without reasons given	Yes	No
c) Withdraw from the study at any time without affecting your future health care or relationship with the Chiropractic day clinic at the Durban Institute of Technology.	Yes	No
8. Do you agree to voluntarily participate in this study	Yes	No
9. Who have you spoken to regarding this study?		

If you have answered NO to any of the above, please obtain the necessary information from the researcher and / or supervisor before signing. Thank You.

Please print in block letters:

Focus Group Member: _____ Signature: _____

Witness Name: _____ Signature:_____

Researcher's Name: _____ Signature:_____

Supervisor's Name: _____ Signature:_____

APPENDIX F- QUESTIONNAIRE: FOCUS GROUP

Questionnaire

All questionnaires are strictly confidential. Please answer as truthfully as possible and tick one box per question unless otherwise indicated. Thank you again for your participation.

Part A: Identification

1. How old are you? (Please tick the appropriate box).

16-24 years	
25-34 years	
35-44 years	
45-64 years	
Older than 64 years	

2. Are you male or female?

Male	
Female	

3. How many years have you been in the fire service?

1-2 years	
2-5 years	
5-7 years	
7- 10 years	
More than 10 years	

4. What is your employment status?

Full time	
Part- time	

5. To which ethnic/cultural group do you belong to? (for statistical purposes only)

Black	
White	
Coloured	
Indian	
Other	

6. What is your marital status?

Single	
Married	
Separated	
Divorced	
Widow(er)	

7. What is your position in the fire service?

Learnership firefighter	
Leading firefighter	
Station officer	
Division officer	
Division commander	
Regional commander	
Chief/ Deputy Chief	

Part B: History of Injuries

For the following questions only consider injuries that occurred in the last year. Please note the word 'injury' pertains to musculoskeletal injury. Burns, cuts etc. not apply.

1. How many injuries have you sustained during training or on the fire ground?

During training	
On the fire ground	

2. Which body part(s) where injured? (more than one answer is possible)

Face	
Head	
Neck	
Shoulder	
Upper arm	
Elbow	
Forearm	
Hands/fingers	
Chest/ribs	
Upper/mid back	
Low back	
pelvis	
groin	
Front of thigh	
Back of thigh	
knee	
Calf	
Shin	
Ankle	
Foot/toes	

3. How did you injure the body part(s)? (more than one answer is possible for multiple injuries sustained)

Climbing	
Working in Enclosed Spaces	

Working in awkward positions	
Lifting Heavy Objects / Incorrect Lifting	
Handling Ladders	
Digging	
Pushing / Pulling Objects	
Operating a charged fire-hose	
Handling unconscious casualties	
Crush I	
Over Exhaustion	
Overuse	
Working in / under water	
Crawling	
Jumping	
Motor vehicle accident en route to fire ground	
Operating Cutting Equipment	
Vibration Injury	
Injured by falling objects	
Other	

If other, please specify

_____

4. What was the diagnosis of the injury / injuries (more than one answer is possible if multiple injuries have been sustained)

Strain	
Sprain	
Tendonitis	
Disc injury	
Muscle Tear	
Muscle Contusion (bruising)	
Fracture	
Crush Injury	
Dislocation	
Ligamentous Tear / Strain	
Overuse Injury	
Other	

5. If other, please specify_____

6. What treatment did you receive? (more than one answer is possible)

Medical	
Physiotherapy	
Chiropractic	
Self Treatment	
None	
Other	

7. What treatment was administered? (more than one answer is possible)

Ice / Cold	
Compression	
Heat	
Dry Needling	
Joint Mobilisation	
Splinting	
Drug Therapy	
Elevation	
Ultrasound	
TENS	
Interferential Therapy	
Muscle Stimulation	
Deep Friction	
Stretching	
Strapping	
Exercise Therapy	
Spinal Manipulation	
Surgery	

8. Was the treatment successful?(i.e. no further symptoms presented or full return to work) ☐ Yes ☐ No

9. How much of time was lost from work due to injury?

No time lost from work	
0-1 week lost from work	
1-2 weeks lost from work	
2-4 weeks lost from work	
More than 4 weeks lost from work	

Part C: Fitness

1. How would you rate your general health?

Excellent	
Good	
Moderate	
Poor	

2. What is your height?

1.5-1.75m	
1.75-2m	
More than 2m	

3. What is your weight?

55-65 kg	
66-75 kg	
76-85 kg	
86-95 kg	
96-110 kg	
More than 110kg	

4. On average, how often do you train per week?

0-1 times a week	
1-2 times a week	
2-3 times a week	
More than 3 times a week	

3. On average, how long do you train for in one session?

0-30 min	
30 min-1 hour	
1-2 hours	
More than 2 hours	

4. Do you have a warm-up session prior to training?

Yes	
No	

5. If you answered YES to Question 4, how long is your warm-up session?

5 min	
10 min	
15 min	
More than 15 min	

6. Do you perform or undertake strength training as part of your work out?

Yes	
No	

Part D: Stress levels

1. How would you rate your stress levels generally?

High	
Moderate	
Low	

2. How would you describe your sleeping patterns?

Very good, regular	
Satisfactory	
Disturbed sleep	
Difficulty falling asleep	
Unable to sleep at all	

3. How would you describe yourself in the working environment?

Alert and energetic	
Moderately aware and active	
Lethargic and fairly aware	

4. Do/ did you suffer from any of the following stress-related illnesses?

High blood pressure	
Migraines	
Depression	
Ulcers	
Heart burn	
Stroke	
Heart attack	
Other heart condition(s)	
Eczema	
Low back pain	
Hair loss	

5. Are you a smoker?

Yes	
No	

6. If yes, on average how many cigarettes do you smoke a day?

1-5 a day	
6- 10 a day	
11-15 a day	
16-20 a day	
More than 20 a day	

Part E: Protective gear

1. Which of the following protective gear do you utilise during fire fighting tasks?

Helmet	

Nomex/PBI hood	
SCBA respirator face piece	
SCBA harness/pack	
Turnout/bunker coat	
Turnout/bunker pants	
Fire fighting boots	
Gloves	
Non SCBA respirator	

2. How comfortable are you in your protective gear?

Yes, excellent fit	
Satisfactory fit	
Poor fit	

3. Do you feel that your posture or movement is sometimes hindered by gear during fire fighting?

Yes	
No	

4. If yes, please specify_____
_____

Part: F Preventative Measures

1. Are you given advice regarding correct working postures?

Some	
Little	
None	

2. Are you given advice regarding correct lifting techniques to protect your lower back?

Some	

Little	
None	

3. Are you given nutritional advice on what to eat and drink?

Some	
Little	
None	

4. Do you feel that you have been given sufficient training and advice regarding the prevention of musculoskeletal injuries?

Yes	
No	

* Thank you for participating in this study*

APPENDIX G- FOCUS GROUP TRANSCRIPT

Focus Group Transcript

Ok you should give everyone an introduction and tell them about the questionnaire.
Good morning, everyone. Thank you all so much for coming to help with this questionnaire. What we actually need to do here today is look at this questionnaire and see if will help collect information for my study, which is "The prevalence and risk factors of occupational musculoskeletal injuries in the Durban Metropolitan fire Department. What I have here is a copy for everyone and some forms to fill in. these are informed consent and letters of information about the study.
The questionnaire has six parts. These are identification, injury history, fitness, stress, protective gear and preventative measures. How should we discuss this Charmaine?

Ok, we will start from question one and work sequentially.
Sure, no problem.
Does anyone have a problem with question one, "How old are you?"
No.
No.
Nope.
It's fine.
Yeah, fine.
Ok, question two also looks fine to me," Are you male or female?"
Yep.
Good.
No probs.
Ok.
Ok.
Ok question 3, "How many years have you been in the fire service?"
Have you chosen a specific number of years that they have to be in the service in order to qualify to be in the study?
Yeah, three years.
Why three years?
It was used in a similar study on low back pain in firefighters.
Ok, so why not change this to 3-5, 6-10, 11-15 and so forth?
That would be better.
Otherwise you can't gauge who has been there for a shorter time.
Ok, next. "What is your employment status?"
Ok, can I jump in there? Listen we work four shifts a week and there are four teams. So it pretty much is part time anyway.
True.
Ok, so we omit that one.
Marital status?
No problem there.
Yeah.
Ok, question, ethnic group, you need to add in brackets "For statistical purposes only."
Ok, let me write that down.
Good.
By the way, how many of these are going out?

About 350.
That's a lot. In just the one station?
No, to the whole department.
I thought we were only doing the one station down here.
No, I discussed with you. It's the whole Department. Unless we just do the one station?
You can't change that now.
Sorry about that everyone, just a supervisor-student miscommunication.
Ok, let's continue.
Ya I think you should move questions 3 down to question 7. Do all the demographics first then the employment details. What does everyone think?
Makes sense.
Yes.
Yeah.
Ok, position in the service?
Well look, there really isn't the position of learnership firefighter and division officer so leave those out.
How come?
Our structure here doesn't require them. Overseas, like America, their fire services are larger so they need more management.
Ok.
Agreed?
Yes.
Yes.
Another thing is we attend different types of fires so maybe you should include that.
How so?
Some of the guys will attend more bush fires and shack fires. The injuries there may be different. For example, we attend more ship and oil fires. So the guy may have fall and slips in the bush fires. But we have more falls from heights or like last year I had a brick wall collapse and I hurt my shoulder.
Good point.
Yeah, interesting. So include that after years in service.
Ok.
Just give her time to write it down.
Ok I think the next section should start with "Are you currently suffering from a WRMSI.
Good idea. I didn't think of that.
Nice.
Ok.
Is everyone ok with that?
Yes.
Good.
Yep.
Ok, this next question about body parts, I think we should use a diagram.
I disagree, this table is better.
How?
A person may not know the name of the area.
Yeah that's why a diagram is better.
No like in practice, a person says they have low back pain but come in and show me their hip.
That's what she is saying.
No it isn't.

Yes you are giving the argument for using a diagram.
Oh…Oh yes right. Sorry.
He used a diagram in his questionnaire. Get that diagram. Here.
Thanks, I will ask him.
Ok next question, you can jump in here.
Well, look she has majority of the causes down. But maybe add some others. Look, when we go to a fire call, you don't just go up to the victim and say "Hi. Did you break a fingernail?" No, it tiring and you get dehydrated. Maybe consider adding fatigue, heat exhaustion, smoke inhalation, even chemical exposure. Oh, yes, and running. Running is difficult with the fire suit. It really restricts movement.
Ok, I agree.
Cool.
Next, "What was the diagnosis?"
I think we should also consider dumbing it down a bit. We need to put these in a language everyone understands. An idiot has to look at this questionnaire and understand it.
Thankfully firemen aren't idiots.
I'm not saying that. That's the point of this focus group. The words need to be easy to understand and unambiguous.
Ok, how about "What would you describe your injury as?"
Sounds good.
It's better.
Yep.
Ok, treatment?
I don't see any problems, but you need to justify these tables. Put the text to the left. They need to have a standard presentation.
Ok, will do.
This next question, I think you should omit it.
Yeah, I agree.
I don't think they will know half of them.
Yeah, like when I was seeing you at the clinic, I knew that you used a machine, but I don't know what it was called.
Good point.
So everyone agrees.
Yep.
Yeah.
Time lost from work?
It's fine.
Yeah the increments are ok.
Good.
Ok, next section.
"How would you rate your health generally?"
I think its fine.
Easy stuff.
Yeah.
Good.
Height and weight?
Do you think they will know what their height is?
Do you know what your height is?
Yeah 1.68. You?
1.7.
Then I'm sure they will.

They will guys cos we do fitness evaluations every three years and they measure BMI.
No problem.
Yep. It good.
Increments are fine.
Ok.
Training?
It's fine.
I think you should add a question about stretching.
Me too.
Ok.
Add a yes/no and length.
I agree.
Ok, let me write it down.
I think we should change the presentation of this question, "Do you have a warm up session?" Perhaps add "prior to training?"
I agree. Sounds better, less ambiguous too.
True.
Ok, I will.
Strength training?
We have some equipment at the station but not much. A lot of the guys gym.
So its fine?
Fine by me.
Yeah.
Stress levels?
I think its ok.
What would you say are big contributors to stress?
Look the things we see are quite bad and we do have some debriefing. But the guys try to be tough but firefighters are people too. There are some admin problems too, you know like pay structure and experience. It can be stressful too. Sometimes a guy would work like at Gilletts for ten years but would less experience than the guys here at the city but would get more money or a promotion.
Understandable.
What shifts do the guys work?
Day is 9-6 and night is 6-9. You work four shifts a week.
Ok.
Stress-related illnesses?
Seems fine the list covers it.
I think you should add stress-related symptoms.
Like?
Fear, nightmares, palpitations…
Good idea. Didn't think of that.
Any others?
Increased alcohol consumption?
Yeah, but just look it up.
Thanks.
Ok.
Ok, smoking?
It's fine but why not add previous history?
Ok.
Ok, so if yes; how many and for how long.
Yeah and for how long have they stopped?

Awesome guys.
Ok, have I missed out any gear on the list?
Seems fine, you just left out fatigues.
Oops, sorry I didn't come across that.
Ok, I like the open-ended question. That should give the gys a chance to complain lol. These seem fine.
Now, preventative measures.
We are given a little advice during training but mostly for lifting.
Nutritional?
Good question. Not too much. The guys love their take-out.
This look fine.
Ok you need to work on the layout. Make the tables the same size and justify to the left.
Ok. Thanks so much for coming so early this morning.

APPENDIX H - LETTER OF INFORMATION

DURBAN UNIVERSITY of TECHNOLOGY

LETTER OF INFORMATION

Date:
Dear Participant, welcome to my research study.

Title	**:**	**An investigation into the prevalence and risk factors of occupational musculoskeletal injuries in firefighters in the Durban Metropolitan Fire Department.**
Name of student	**:**	**Dhimunthree Albert, Contact number: 031 3732512**
Name of Supervisor/s	**:**	**Dr. N. Gomes (MTech Chiropractic, USP. MMedSc Sports Medicine)** **Dr. C. Korporaal (MTech Chiopractic. CCFC, CCSP, ICSSD)**

Background to the Study:
Firefighters have a number of occupational risk factors that listed in the reviewed literature for the development of musculoskeletal injuries (Reichelt and Conrad, 1995; Guidotti, 1998; Nuwayid *et al.,* 1995). Musculoskeletal injuries are problems affecting the muscles, tendons, ligaments and nerves or other soft tissues and joints.
Physical lifting of equipment and casualties increases stress on the low back, and occupational stress as well as a high level of public responsibility are mental risk factors (Davis and Heaney, 2000). Due to the nature of their occupation, firefighters face an increased risk of cardiovascular disease, post-incident psychological stress and strain injury due to improper lifting (Guidotti, 1998).

Outline of procedures:
You have been selected to participate in this study investigating the prevalence and risk factors of musculoskeletal injuries in the fire service over a period of the last three years. Please complete the questionnaire provided if you have been the fire service for a minimum of three years and are a registered member of SAESI.

Risks, discomfort or research-related injury
There will be no risks,discomfort or any research-related injury to participants.

Renumeration and costs:
There will be no renumeration or cost associated with this study.

Benefits of the study:
The identification of the prevalence and risk factors of musculoskeletal injuries in the fire service can lead to the formation of strategies to improve occupational health and safety.

Confidentiality and ethics:
Your participation is voluntary and you are free to withdraw from this study at any time. The information given is also confidential, so please do not write your name anywhere on the questionnaire. All information will be treated with the strictest of confidence and the results of the study will be made available to all participants on request.

Please do not hesitate to ask for clarification on any aspect of this study. Should you have any queries or complaints, kindly contact the Head of the Faculty of Health Sciences Research Committee, Prof. N. Gwele on 031 3732704. Thank you for your participation.

Yours sincerely,

D. Albert

DURBAN UNIVERSITY of TECHNOLOGY

APPENDIX I- INFORMED CONSENT FORM

INFORMED CONSENT FORM
(To be completed by patient / subject)

Date	**:**
Title of research project	**: An investigation into the prevalence and risk factors of occupational musculoskeletal injuries in the Durban Metropolitan Fire Department**
Name of supervisor/s	**: Dr. N. Gomes (MTech Chiropractic, USP. MMedSc (Sports medicine)**
	: Dr. C. Korporaal (MTech Chiropractic. CCFC, CCSP, ICSSD)
Tel	**: 031 5727000**
Name of research student	**: Dhimunthree Albert**
Tel	**: 031 3732512**

Please circle the appropriate answer

	YES /NO	
10. Have you read the research information sheet?	Yes No	
11. Have you had an opportunity to ask questions regarding this study?	Yes No	
12. Have you received satisfactory answers to your questions?	Yes No	
13. Have you had an opportunity to discuss this study?	Yes No	
14. Have you received enough information about this study?	Yes	No
15. Do you understand the implications of your involvement in this study?	Yes No	
16. Do you understand that you are free to withdraw from this study?	Yes No	
at any time	Yes	No
without having to give any a reason for withdrawing, and	Yes No	
without affecting your future health care.	Yes	No
17. Do you agree to voluntarily participate in this study	Yes	No
18. Who have you spoken to? _____		

Please ensure that the researcher completes each section with you
If you have answered NO to any of the above, please obtain the necessary information before signing

Please Print in block letters:

Patient /Subject Name: _____ Signature: _____

Witness Name: _____ Signature: _____

Research Student Name: _____ Signature: _____

APPENDIX J: FINAL QUESTIONNAIRE

All questionnaires are strictly confidential. Please answer as truthfully as possible and tick one box per question unless otherwise indicated. Thank you again for your participation.

Part A: Identification

1. How old are you? (Please tick the appropriate box).

16-24 years	
25-34 years	
35-44 years	
45-64 years	
Older than 64 years	

2. Are you male or female?

Male	
Female	

3. To which ethnic/cultural group do you belong to? (for statistical purposes only)

Black	
White	
Coloured	
Indian	
Other	

4. What is your marital status?

Single	
Married	
Separated	
Divorced	
Widow(er)	

5. What is your position in the fire service?

Leading firefighter	

Station officer	
Division commander	
Regional commander	
Chief/ Deputy Chief	

6. How many years have you been in the fire service?

3 – 5 years	
6 – 10 years	
11-15 years	
16-20 years	
21-25 years	
26-30 years	
31-35 years	
More than 36 years	

7. Do you mainly attend urban or rural fires?

Urban fires (Structural, ship and MVC fires)	
Rural fires (Veld, MVC and shack fires)	

Part B: History of Injuries

For the following questions only consider injuries that occurred in the last three years **at work** and **during training**. Please note the word 'injury' pertains to musculoskeletal injury. Burns, cuts etc. not apply.

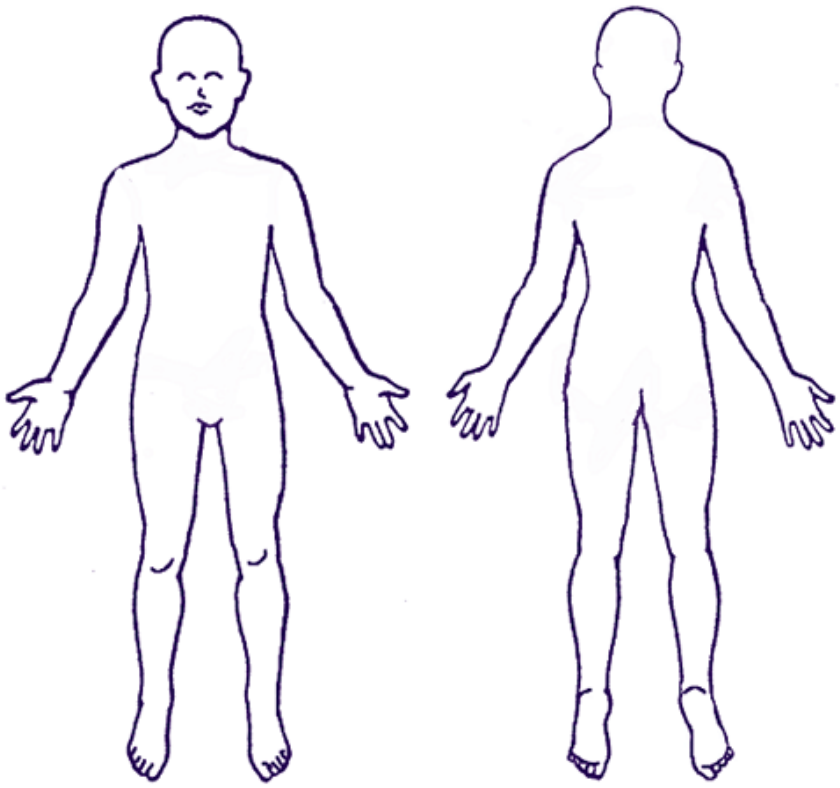
1. Are you currently (right now) suffering from a work-related musculoskeletal injury?

Yes	
No	

2. How many injuries have you sustained during training or on the fire ground that have resulted in lost work time?

During training	
On the fire ground	

3. Please draw a cross on the appropriate body areas/parts to indicate where injuries were sustained in the last five years.



4. How did you injure the body part(s)? (more than one answer is possible for multiple injuries sustained)

Climbing	
Working in Enclosed Spaces	
Working in awkward positions	
Lifting Heavy Objects / Equipment or Incorrect Lifting	
Handling Ladders	
Digging	
Pushing / Pulling Objects	
Operating a charged fire-hose	
Handling unconscious casualties	
Crush Injuries	
Over Exertion	
Overuse	
Working in / under water	
Crawling	
Jumping	
Motor vehicle accident	

Smoke Inhalation	
Chemical Exposure	
Operating Cutting Equipment	
Heat Exhaustion	
Injured by falling objects	
Fatigue	
Running	
Other	

If other, please specify

_____

5. What would you describe the injuries as?

Strain	
Sprain	
Tendonitis	
Disc injury	
Muscle Tear	
Muscle Contusion (bruising)	
Fracture	
Crush Injury	
Dislocation	
Ligamentous Tear / Strain	
Overuse Injury	
Other	

6. If other, please specify_____

7. What treatment did you receive? (more than one answer is possible)

Medical	
Physiotherapy	
Chiropractic	
Self Treatment	
None	
Other	

8. Was the treatment successful?(i.e. no further symptoms presented or full return to work) Yes ☐ No ☐

9. How much of time was lost from work due to injury?

10.

No time lost from work	
0-1 week lost from work	
1-2 weeks lost from work	
2-4 weeks lost from work	
More than 4 weeks lost from work	

Part C: Fitness

1. How would you rate your general health?

Excellent	
Good	
Moderate	
Poor	

2. What is your height?

1.5-1.75m	
1.75-2m	
More than 2m	

3. What is your weight?

55-65 kg	
66-75 kg	
76-85 kg	
86-95 kg	
96-110 kg	
More than 110kg	

4. On average, how often do you train per week?

0-1 times a week	
1-2 times a week	
2-3 times a week	

More than 3 times a week	

3. On average, how long do you train for in one session?

0-30 min	
30 min-1 hour	
1-2 hours	
More than 2 hours	

4. Do you do stretching exercises before training?

Yes	
No	

5. Do you have a warm-up session prior to training?

Yes	
No	

6. If you answered YES to Question 4, how long is your warm-up session?

5 min	
10 min	
15 min	
More than 15 min	

7. Do you perform or undertake strength training as part of your work out?

Yes	
No	

Part D: Stress levels

1. How would you rate your stress levels generally?

High	
Moderate	
Low	

2. How would you describe your sleeping patterns?

Very good, regular	
Satisfactory	
Disturbed sleep	
Difficulty falling asleep	
Unable to sleep at all	

3. How would you describe yourself in the working environment?

Alert and energetic	
Moderately aware and active	
Lethargic and fairly aware	

4. Do you suffer from any of the following stress-related symptoms?

Nightmares	
Fear	
Hallucinations	
Withdrawal from social activities	
Poor concentration	
Agitation/irritability	
Increased alcohol consumption	
Palpitations	
Weakness	
Hyper vigilance	
Headaches	
Profuse sweating	
Loss of appetite	

5. Do/ did you suffer from any of the following stress-related illnesses?

High blood pressure	
Migraines	
Muscular stiffness and pain	
Depression	

Ulcers	
Heart burn	
Stroke	
Heart attack	
Other heart condition(s)	
Eczema	
Low back pain	
Hair loss	

6. Are you a smoker?

Yes	
No	

7. If YES, on average how many cigarettes do you smoke a day?

1-5	
6- 10	
11-15	
16-20	
More than 20	

8. Do you have a previous history of smoking but have now stopped?

Yes	
No	

9. If YES to 8) above: How many cigarettes did you smoke per day?

1 - 5	
6 - 10	
11 - 15	
16 - 20	
More than 21	

10. How many years did you smoke for?

1– 2 years	
3 – 4 years	
5 – 6 years	
7 – 8 years	
More than 9 years	

11. How many years has it been since you stopped smoking?

0 – 2 years	
3 – 5 years	
6 – 8 years	
More than 8 years	

Part E: Protective gear

1. Which of the following protective gear do you utilize during fire fighting tasks?

Helmet	
Nomex/PBI hood	
SCBA respirator face piece	
SCBA harness/pack	
Turnout/bunker coat	
Turnout/bunker pants	
Fire fighting boots	
Gloves	
Non SCBA respirator	
Fatigues	

2. How comfortable are you in your protective gear?

Yes, excellent fit	
Satisfactory fit	
Poor fit	

3. Do you feel that your posture or movement is sometimes hindered by gear during fire fighting?

Yes	
No	

4. If yes, please specify_____

Part: F Preventative Measures

1. Are you given advice regarding correct working postures?

Some	
Little	
None	

2. Are you given advice regarding correct lifting techniques to protect your lower back?

Some	
Little	
None	

3. Are you given nutritional advice on what to eat and drink?

Some	
Little	
None	

4. Are you given advice regarding the importance of maintaining a high level of physical fitness?

Some	
Little	
None	

5. Do you utilise the advice regarding injury prevention provided by the training officer at all times?

All the time	
Sometimes	
Never	

6. Do you feel that you have been given sufficient training advice regarding the prevention of musculoskeletal injuries?

Yes	
No	

Thank you for participating in this study.