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SCHOOL OF PUBLIC HEALTH COLLEGE OF HEALTH SCIENCES UNIVERSITY OF GHANA, LEGON

ASSESSMENT OF MUSCULOSKELETAL DISODERS AMONG HEAVY EQUIPMENT OPERATORS AT THE GHANA PORTS AND HARBOURS AUTHORITY, TEMA

BY

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THIS DISSERTATION IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF SCIENCE IN OCCUPATIONAL HYGIENE DEGREE

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DECLARATION

I, Veronica Ama Foli-Fiakpoey Asangbah, declare that except for the other people's investigations which have been duly acknowledged, this work is the result of my own original research, and that this dissertation, either in whole or in part has not been presented elsewhere for another degree.

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Veronica Ama Foli-Fiakpoey Asangbah DATE

STUDENT

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Dr. Uri Selorm Markakpo DATE

ACADEMIC SUPERVISOR

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DEDICATION

This dissertation is dedicated to my husband, Charles Kwame Asangbah, whose love and support gave me the strength needed to achieve my goals; and to my son, Robert Selase Kofi Asangbah, for his remarkable patience and encouragement.

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ABSTRACT

Background Generally, heavy equipment operators such as forklifts drivers and cranes operators perform various tasks that expose them to many hazards which may lead to health problems. Whole body vibration, awkward postures, repetitive movement, are some of the hazards that heavy equipment operators are exposed to.

Objective Investigations were therefore conducted to access Musculoskeletal disorders (MSDs) among heavy equipment/ machine operators of the Ghana Ports and Harbours Authority (GPHA) in the Tema metropolis.

Method The study adopted a cross-sectional and quantitative data collection approach, using an adapted Nordic musculoskeletal disorder questionnaire and personal interviews. A total number of 100 heavy equipment operators were selected using simple random sampling technique**.** Generally, the study showed that most of the heavy equipment operators were exposed to numerous hazards at work such as awkward postures, whole-body vibration, prolonged sitting and repetitive motions which might have contributed to the development of the MSDs reported in some of them.

Results The results revealed that the prevalence of musculoskeletal conditions was highest for neck pain (42%), upper back pain (40%), lower back pain (55%), hand pain (44%) and pains in the hips and thighs (51%). Also, there was significant association between the musculoskeletal injuries observed among the heavy equipment/ machine operators and the risk factors of the disease ($p<0.05$). This study also found a significant association between the number of hours spent per session operating heavy machinery and years of employment as a heavy equipment operator and the occurrence of MSDs ($p<0.05$).

Conclusion This study therefore accentuate the need for management to put in place appropriate measures that will help minimize adverse health effects that arise from the operation of heavy equipment by the employees of GPHA.

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LIST OF ABBREVIATIONS

GPHA	Ghana Ports and Harbours Authority
MSDs	Musculoskeletal Disorders
WMSDs	Work-related Musculoskeletal Disorders
WBV	Whole-Body Vibration
LBP	Lower Back Pain
NMQ	Nordic Musculoskeletal Questionnaire
WCBBC	Workers' Compensation Board of British Columbia
SPSS	Statistical Package for Social Sciences
WSIB	Workplace Safety and Insurance Board
PNDC	Provisional National Defence Council

INTEGRI PROCEDAMUS

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CHAPTER ONE

1.0 INTRODUCTION

The musculoskeletal system consists of the bones, muscles, ligaments and tendons. The bones are the load-bearing structure of the body, the muscles are tissues that contract and relax to create movement while the tendons are tissues that connect muscles to bones. Ligaments are tissues that connect bones to bones, cartilage are tissues providing cushioning and reduces friction between bones, nerves are the communication systems that link muscles, tendons and other tissues with the brain and blood vessels are tubes that circulate nutrients throughout the body.

Some of the functions of the musculoskeletal system is to allow movement and to give shape to the body. Injuries to the musculoskeletal system can be acute or can accumulate over a period of time which will eventually become chronic and will result in pain and discomforts (Tinubu, 2015).

Heavy machine operators are individuals who operate power equipment such as bulldozers, power shovels, excavators, scrapers, trucks, loaders, cranes, and forklifts. Operators of these machines are known to have higher rates of musculoskeletal injuries than non-operators (Jorgensen et al 2007). Professional fork-lift, truck and trailer drivers as well as crane operators at the ports are at risk of MSDs due to the nature of their tasks.

The operators of heavy equipment often sit for prolonged hours during which they assume awkward and static postures and work for long hours carrying out repetitive operations of equipment, and that cause vibrations throughout the body. Brebbia (2012) indicates that, drivers of heavy equipment are often required to drive for long and sometimes irregular hours during which they are exposed to prolonged sitting, whole body vibration and repetitive movements of body parts such as arms, legs and head all of which are major risk factors for

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Work-related Musculoskeletal Disorders (WMSDs) among these workers. The effects of the risk factors may depend on the intensity of the exposure, the duration and the frequency.

Musculoskeletal disorders (MSDs) are recognized as the cause of non-fatal injuries and disabilities in working population including heavy equipment operators (United States Department of Labor 2014). Even though developed countries such as the United States of America and the United Kingdom have carried out a number of studies, virtually none of such studies has been conducted in Ghana. According to Erick and Smith (2011) for instance, MSDs represent one of the most common and sometimes the most expensive occupational health problems in both developed and developing countries. Bevan et al., (2007) carried out a study in the United Kingdom which indicates that musculoskeletal conditions comprises 55 percent of all work-related illnesses as compared to stress which was 30 percent.

MSDs may increase the cost of doing business where companies had to pay higher medical bills for their injured employees, higher worker's compensation premiums, increased employee turnover, absenteeism, retraining of employees may occur, low productivity and employee morale may also suffer (United States Department of Labor 2014). Although several studies have addressed issues of how effectively MSDs symptoms can be controlled, the causes of MSDs are frequently assumed and largely unknown which make outright prevention sometimes difficult. It is in view of these that this study proposes to identify the different types of MSDs that exists among heavy equipment operators in the selected institution in Ghana, in order to describe approaches for prevention of the problem.

Preventing the onset of MSDs, helps to reduce job related disabilities, loss of working hours, absenteeism, increase employees turnover, low productivity and high cost of insurance claims from companies. Also, MSDs prevention leads to increased job satisfaction and boosts the morale of the average worker.

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1.1 STATEMENT OF THE PROBLEM

Heavy equipment driving has often been associated with the development of MSDs. Transactions on Information and Communication Technologies (2012) indicated that the Workplace Safety and Insurance Board (WSIB) in Ontario, Canada revealed that the average lost time injuries reported yearly by heavy equipment operators was 102 where the total injuries reported in 1998 shows that 29% were to the back, 12% to the shoulder or arm and 9% to the ankle.

In Ghana, the working population visits various hospitals with the complaints of musculoskeletal disorders and discomforts. In Tema for instance, where there is a port and many manufacturing companies, a lot of employees visit the Tema General Hospital complaining of low back pain, neck and/ or shoulder pain, leg pain, arms and wrist pains (Tema General Hospital, 2010). Also, many staff of Ghana Ports and Harbours Authority (GPHA) do absent themselves from work in order to seek medical solution to musculoskeletal problems (Ghana Health Service, 2010). Although some research has been done to control MSDs symptoms virtually no work has been done to outline the causes and ways to prevent them.

Preventing the onset of MSDs will however reduce disabilities, increase job satisfaction of staff, reduce loss of working hours and will boost morale of staff of GPHA. It is therefore necessary to investigate the factors that contribute to MSDs among heavy equipment operators at GPHA and recommend measures for prevention of such problems among that staff.

1.2 JUSTIFICATION OF THE STUDY

The port of Tema has been expanding rapidly. This expansion has brought about increase in the port's facilities to be capable of handling more heavy duty equipment and cargos. This puts an increased responsibilities on human operators of lifts, cranes and other load moving machinery since they have to operate these sophisticated machines in lifting and

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handling of these heavy loads. Much as there has been an increase in the handling of heavy equipment, musculoskeletal disorder complaints have also increased among these workers. It is therefore necessary to investigate whether there are any associations between the tasks being performed by heavy equipment operators and the complaints of MSDs

Many studies on MSDs have attempted to address issues related to the effective control of MSDs symptoms among workers with limited or no knowledge of the actual causes of MSDs which makes prevention difficult. This study to assess the MSDs among heavy equipment operators of GPHA will help identify the causes of the problems and suggest measures towards prevention of their occurrence.

1.3 CONCEPTUAL FRAMEWORK

The conceptual framework in figure 1 shows and defines the relationship between biomechanical and psychological factors that may contribute to MSDs in heavy equipment operators. Biomechanical factors such as awkward postures, prolonged sitting, body vibration and repetitive arm motions can cause lower and upper body pain, shoulder pain, neck pain, waist pain, wrist pain, hand pain, arm pain and leg pain which will eventually lead to the development of MSDs.

With regards to psychological factors such as high job demands, low job satisfaction, low supervisor supports and low social support will cause stress, anxiety and depression which can cause MSDs. For instance, poorly assumed awkward postures while operating a heavy equipment will most likely result in lower back pain or shoulder pain.

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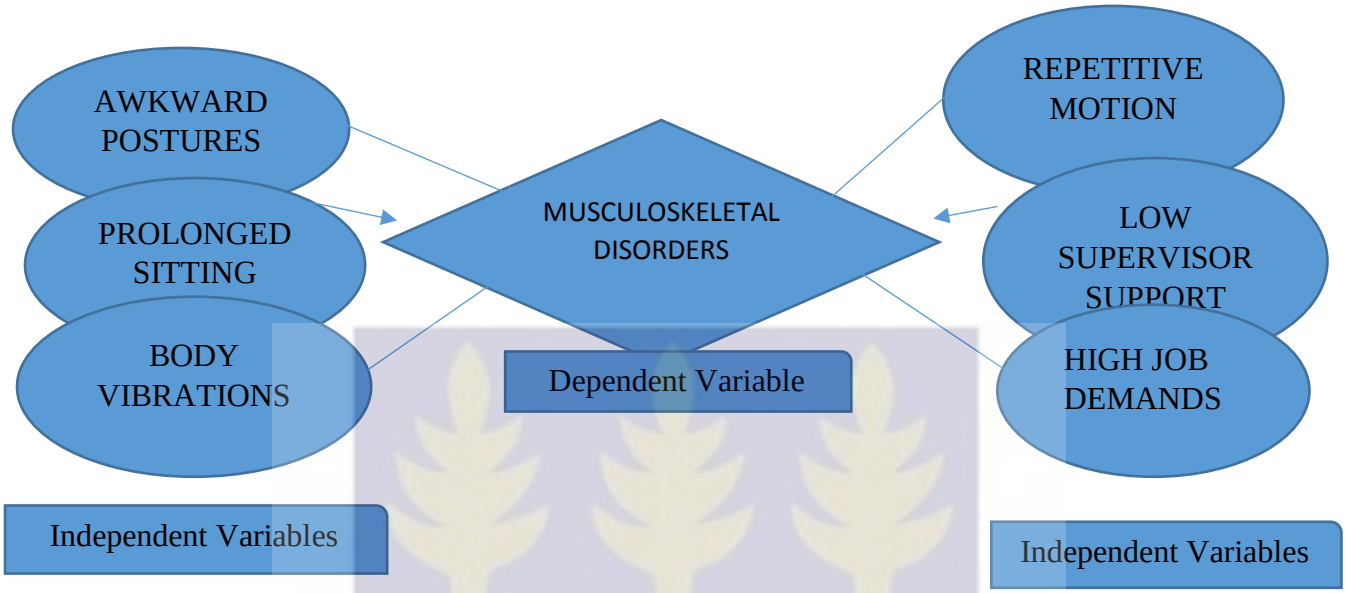
FIGURE 1: CONCEPTUAL FRAMEWORK FOR MUSCULOSKELETAL DISORDERS



Source: Author's own construct, 2016.

1.4 Research Questions

The research was guided by the following questions

1) What factors contribute to MSDs among heavy equipment operators?

2) What type of MSDs do the heavy equipment operators experience?

3) Do MSDs have any effect on work performance among heavy equipment operators?

1.5 Study Objectives

1.5.1 Main Objective

The main objective of the study was to determine the factors that contribute to musculoskeletal disorders (MSDs) in heavy equipment operators at the Ghana Ports and Harbours Authority (GPHA) and recommend measures for their prevention.

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1.5.1.1 Specific Objectives

1) To assess the different types of MSDs suffered by heavy equipment operators.

2) To determine the association between heavy equipment operations and musculoskeletal injuries.

3) To investigate whether age, number of years worked and number of hours worked in a day significantly influence MSDs.

4) To propose interventions in regards to workplace ergonomics which will help prevent or reduce MSDs.

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CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

This chapter presents an important literature review of MSDs and their contributing risk factors. The purpose of the literature review was to identify and examine the existing information regarding musculoskeletal disorders in general, its contributing risk factors, the main MSDs been experienced and how they affect the heavy equipment operators at the Ghana Ports and Harbours Authority (GPHA).

2.2 Definition of Musculoskeletal Disorders (MSDs)

Musculoskeletal Disorders, (MSDs) are injuries to the joints, muscles, tendons, nerves and ligaments. Examples of such disorders are carpal tunnel syndrome, ligaments sprain, muscle strain, tendonitis, tension neck syndrome, back pain and radial tunnel syndrome. According to Stock et al. (2005), musculoskeletal disorder (MSD) is a global term used to describe several types of disorders that affects the neck, back, upper limbs or lower limbs which affects tissues including tendons, muscles, ligaments, nerves and joints.

Punnet & Wegman (2004) also confirms that MSDs includes a wide range of inflammatory and degenerative conditions that affects the muscles, tendons, ligaments, joints, peripheral nerves and blood vessels and the term "disorder" gives an indication that the nature of these conditions often develops from more than one risk factor or exposure sources. According to Schneider & Irastorza (2010), Work-related Musculoskeletal Disorders (WMSDs) are painful disorders of the muscles, tendons, joints and nerves which can affect any part of the body even though the upper limbs, the neck and the back are mostly affected. Work-related MSDs are physiological conditions that develop over a period of time such as in weeks,

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months or even years due to prolonged mechanical stresses on the musculoskeletal system that results in physical ailments that are marked by pain (HamilWeight & Hardy 2015).

Silverstein & Evanoff (2011) reports that WMSDs accounts for 29% of all United States workplace injuries. MSDs excludes conditions such as lacerations, fractures and abrasions which occur when the physical body comes in contact with an external object (Centers for Disease Control and Prevention, Musculoskeletal Disorders, 2016). Repetitive strain injuries, degenerative joint diseases, repetitive motion injuries, overuse syndrome and cumulative trauma disorders are other terms that can be used in place of MSD (U.S, Department of Health and Human Services, 1995). Some experts of World Health Organization (WHO) in 1985 had selected two syndromes considered to be work-related which are lower back pain, neck and shoulder pain and the occupational work involving risk factors such as awkward body postures, frequent bending and twisting, exposure to general vibration which are found in jobs such as dock workers, miners and heavy equipment operators.

2.3 Musculoskeletal Disorders Experienced by Heavy Equipment Operators

Heavy equipment operators suffer from various MSDs such as low back pain, neck and shoulder pain which affects their productivity. It is important to identify the root causes of these disorders so that appropriate measures can be put in place to prevent future occurrence. The signs and symptoms of MSDs include carpal tunnel syndrome, painful joints, pain in the wrists, shoulders, forearms and the knees, tingling or numbness in hands or feet, fingers or toes turning white, back or neck pain, stiffness, shooting or stabbing pains in the arms or legs, swelling or inflammation, burning sensations, heaviness, weakness or clumsiness in hands. The earlier these signs and symptoms of MSDs are identified and treated, the easier it would be to prevent complications from arising.

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2.3.1 Low back pain

Palmer, Griffin & Syddall (2006) defined Low Back Pain (LBP) as any discomfort in the lower back region involving the twelfth rib and the gluteal folds which may cause radiating pain down in one or both legs that may last for days, weeks, months or years. Low back pain is one of the health problems suffered by heavy equipment work population. Stock et al (2005) also explains that working with the arms extended and unsupported may put a significant stress on the back. A study done by Bovenziet et al (2002) on 219 port machinery operators revealed that they had been exposed to WBV which has increased their risk of developing low back pain.

Operating foot pedals increases the risk of back injury because it require an asymmetric back posture which may impose a static posture, leading to the development of back injury (Stock et al 2005). Back pain is the single most expensive health problem for working age adults and it accounts for 22% of all workers compensation claims (Webster & Snook 1990). Lower back pain is also said to be the second common cause of visits to the primary care physicians (Cypress, 1983; Gallis, 2006).

In the United States of America where lower back pain is a major cause for filing of compensation claims for example, four billion dollars per year are said to be lost to wages due to lower back pain (Pope, & Frymoyer, 1984), and 5.4 million people per year are reported to become disable as a result of lower back pain (Johanning, 2000).

Occupational groups such as heavy equipment operators, truck drivers and people in the construction trades have the highest prevalence of work related back pain (Behrens et al 1994). In Europe for instance, low back pain complaints contributed to 39% of workplace diseases (Schneider & Irastorza, 2010). In addition, it has been reported that low back pain and the upper extremity MSDs are the leading cause of work-related injuries among heavy equipment operators and has been associated with whole body vibration and mechanical shocks caused by tough rides and high accelerations (Waters et al 2008; Silverstein & Evanoff, 2011). Furthermore, a study

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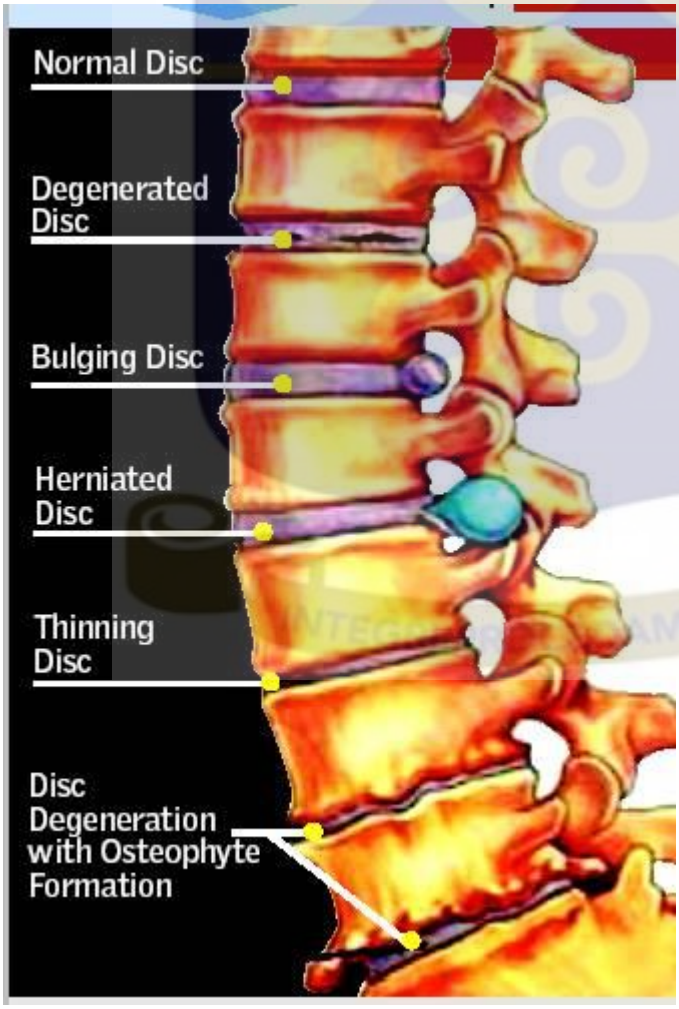
done among underground gold miners in Ghana who use heavy equipment indicates that there is a significate association between low back pain and increasing age (Bio et al 2007).

According to the Workers' Compensation Board of British Columbia (WCBBC 1999), the spine (Figure 2) is made up of 33 bones called the vertebrae and each vertebrae is specially designed to protect the spinal cord and to provide support for the back. Between each of the vertebrae are discs which are like a jelly donuts and when they are pressed down on one side, the other side bulges and puts increased pressure on the discs which may result to back pain and spinal problems.

Figure 2.0 shows examples of discs problems.



The most common disc problems related to both occupational and non-work-related activities.
Source: Adapted from: The Healthy Back Institute

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2.3.2 Neck and shoulder pains

Heavy equipment operators such as cranes and forklift drivers are exposed to risk factors that can result in neck and shoulder pain. A study conducted earlier by Ariens et al (2000), indicated that working with a rotated neck at 45 degrees for 25-30% of the working time, increases the risk of neck pain by 30%. Also, awkward static postures, shoulder elevation and abduction, repetitive movements and forceful exertion have been reported to predispose a working individual to neck and shoulder injuries (Remple et al 2007).

In addition, a study conducted by Maitiet al (2014) showed that cranes height contributes mostly to complaints of MSDs of the lower back, neck and shoulder areas. Brebbia (2012) stated that the results of a musculoskeletal discomfort survey found that heavy equipment such as mobile crane operators do suffer from neck, hip, upper and lower back problems.

Crane operators are frequently required to bend their necks and look behind them, watch the boom, load and signal somebody, or maintain their neck in a static posture, which results in pinched nerves, muscle pain, headaches and sore necks (Electronic Library of Construction Occupational Safety and Health, 2001). Forklift operators are also prone to neck pains, stiff shoulders and fatigue (Stock et al 2005). Lastly, Cote et al (2001) explains that WMSDs affects almost all the body parts but 50% are more related to the back, neck, shoulders and the upper limbs.

2.3.3 Economic cost of musculoskeletal disorders

In 1994, a research conducted on the global burden of injuries and diseases due to occupational factors indicated that the annual incidence of MSDs represented 31% of the world's occupational diseases (Leigh et al 1999). Punnett (1999), reported that the cost of

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treatment of MSDs in general, and should problems among workers of the USA automobile manufacturing industry were $ 2,721 and $ 1,417 respectively.

Also, Middlesworth (2016), reported that one-third of all workers compensation in the United States can be attributed to MSDs and almost 400,000 injuries occur every year where 38% more time days are related to MSDs cases than other average injuries or illness. This means that most workers are affected by MSDs globally but the cost related to MSDs may vary in different industries and occupations.

The NORA Musculoskeletal Disorders Team, (2001) also reports that in the year 2000, MSDs cost United States between $13 billion and $54 billion in worker's compensation claims, loss of workdays, decreased productivity, and other direct and indirect costs. The cost of MSDs may be direct or indirect. The direct cost of MSDs include workers compensation payments, medical bill payments, legal expenses, rehabilitation as well as medical equipment and property damages (Weahrer et al 2005).

Direct cost of MSDs in the United States amounts to 20 billion per annum while the indirect cost can be up to five times the direct cost (Middlesworth, 2016). National Research Council and Institute of Medicine (2001). Also, it has been estimated that the total cost associated with MSDs both direct and indirect, is alone as high as $45-54 billion dollars (National Research Council and Institute of Medicine Report, 2001; Keller, 2000).

Indirect costs of MSDs on the other hand, include training provided for replacing employees, investigating an accident, loss of productivity, lower employee morale and absenteeism. According to Weahrer et al. (2005) indirect costs includes victim productivity losses such as losses in wages, employer losses such as recruiting and retraining provided for replacing the injured workers, accident investigation bills and the quality-of- life cost which will be the pain and suffering by the victims and their families.

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Indeed, the European Agency for Safety and Health at Work (2000), estimated that the direct and indirect cost of work-related upper limb disorders in Britain are £5,251 sterling per the injured worker, while each individual forced to stop working due to work-related injuries loses an average of £51,000 sterling before retirement age. In the USA however, the Agency reports that MSDs of the upper extremities costs more than $2.1 billion in workers compensation each year, with low back disorders costing 11 billion in workers compensation.

2.4 Risk Factors for Musculoskeletal Disorders

Health and Safety Executive ([HSE] 2009), reports that crane operators who engage in loading and offloading container cargos are at risk of developing MSDs. Smedley, Finlay and Sadhra (2014) also reported that some of the risk factors contributing to the development of MSDs are awkward postures, prolonged sitting, whole-body vibration, years of experience, duration of work, age of the operator and repetitive movement.

In relation to age, Ilmarinen & Tuomi (1992), explains that as people age, their wrist, shoulders and back tissues become more vulnerable to harmful effects of awkward postures and repeated exertions which causes decreased blood flow, changes in nutrition and tissue degeneration which increase their risk of developing MSDs.

Various authors have also noted that the main risk factors associated with the operation of heavy equipment are awkward postures, vibrations from jolts and shocks, repeated or continuous use of muscles and psychosocial factors such as shift work, working in isolation and working to meet deadlines (UKHSE report, 2002, Jorgensen *et al.* 2007, Middleworth, 2016).

In addition, Kittusamy & Buchholz (2001), maintained that heavy equipment operators in their course of work are also exposed to conditions such as dust, diesel exhaust, noise, extreme temperatures and psychological health problems such as long working hours, time

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pressures and shift work which leads to chronic inflammatory diseases that often aggravate pain due to MSDs.

Furthermore, the duration of exposure to predisposing factors of MSDs has also been considered as an important risk factor for development of the disease. In respect of this, an earlier study conducted by Zimmerman (1997), indicated that the longer an individual operates a heavy equipment, the more likely it is for him to miss work or seek medical treatment for musculoskeletal pains than others who never or scarcely operated such equipment.

2.4.1 Awkward postures

Postures are positions that a worker assumes while performing a task, whether sitting or standing. Postures may involve bending, twisting or relaxing of muscles and joints in certain parts of the body. It is very important to maintain a natural body postures while performing a task in order to avoid discomforts and musculoskeletal injuries. Wrong body Postures maintained for a prolonged period places a significant stress on the back (Stock *et al*. 2005).

According to Workplace Guidelines for the Prevention of Musculoskeletal injuries (2002), neutral postures will help reduce strains on working muscles and joints and that any posture that requires the body to move away from its neural position is considered to be an awkward posture. Mehta & Tiwari (2000) indicated that heavy equipment operators had to do a lot of turning, bending and twisting movements in the body to look ahead, behind, sideways or downwards while performing their task that constitute awkward body posture, an important risk factor for MSDs. Stock et al (2005) confirmed that heavy equipment operators like forklift drivers have to adopt a posture that exerts intense strains on the back, since they have to drive backs up and look behind while twisting the back.

Awkward posture also involves static sitting, neck flexion and rotation, twisting and bending of the trunk (Rehn, 2002). Awkward posture has also been considered as a risk factor

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for MSDs among operating engineers (Kittusamya & Buchholzb, 2001**).** Indeed, Kumar (2001) reported that maintaining awkward postures over an extended period of time increases the risk of developing MSDs. Awkward postures has been associated with work related MSDs discomforts and injuries to the lower back and neck (Chowdhury, Boricha & Yardi, 2012).

Maintaining awkward postures over an extended period of time increases the risk of developing MSDs. Awkward postures places excessive force on the joints, stresses the ligament and overloads the tendons and the muscles for a sustained periods of time without any adequate recovering time (Middleworth, 2016).

Okunribido et al. (2007) emphasized that, operators of heavy equipment who work in a twisted and bent positions has an increased pressure in their vertebral discs as well as strains in their necks and shoulders. Awkward postures therefore, are major contributing factor for the increased risk of MSDs in forklift drivers and crane operators who usually twist and bend forward while driving (Hoy et al 2005).

Awkward postures can also be influenced by other factors such as the cabin space, visual field, seating quality, control layouts, location and orientation of work, individual work methods and the workers anthropometric characteristics (Kittusamy & Buchholz, 2001). The interior design of a vehicle will determine the postures and postural movements that an operator will assume which in turn has a direct effect on how safely and efficiently a task can be accomplished (Parkinson et al 2007). Poorly designed cabins of heavy equipment may result in the operators assuming awkward postures which can lead to pain and musculoskeletal injuries.

It is also important for heavy equipment operators to have a clear view of the task that they are performing in order to reduce awkward postures while performing a task. Donati (2002) confirmed that, good visibility is very important for safe operations of machines because it prevents assumption of awkward postures or movements. Prolonged sitting and static

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postures have been positively associated with Work related Musculoskeletal Disorders (WMSDs) of the neck, shoulder and lower part of the back (Smedley et al 2014**).**

2.4.2 Whole body vibration (WBV)

According to Workplace Guidelines for the Prevention of Musculoskeletal injuries (2002), whole-body vibration affects tendons, muscles and joints, decreases sensitivity to specific body parts which may lead to injuries and fatigue to those parts of the body. Heavy equipment operators are exposed to Whole-Body Vibration (WBV). Gallais (2008) also indicated that whole-body vibration contributes significantly to early degeneration of the spine and lumber associated muscles and ligaments that lead to MSD. Since heavy equipment operators constantly undergo whole-body vibration, it is not surprising therefore that MSDs is a major health concern for this category of workers (Jorgensen et al. 2007; Middleworth, 2016; HamilWeight & Hardy, 2015).

Furthermore, reports from other studies indicated that MSDs involving lower back pain and damages to the spinal discs are common among heavy equipment operators such as persons who drive buses, loader lorries, cranes and fork-lift trucks (Johanning , 2000; Smedley et al., 2014; Workplace Guidelines for the prevention of Musculoskeletal Injuries, 2002). The main factors noted to be influencing exposure to WBV are vibration of the vehicle because of wear and tear, the design, seating and the suspension of the vehicle, the surface of the road and the road speed. Vibrations can be transmitted through seats causing the whole body to vibrate.

Indeed, Health and Safety Executive (2001) confirmed that factors that cause WBV can pass through the seat to the driver's body and the buttocks or from a platform of a machine to the operator's feet which will cause back damage.

WBV can also originate from the steering wheel which exposes the operator to hand vibration or from the head rest which leads to head vibration. Drivers exposed to WBV for an

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extended time periods have been associated with MSDs like low back pain (Brebbia, 2012; Palmer et al. 2006; Tiemessen et al. 2007).

Reports from various studies have indicated that there is a strong positive association between the exposure to WBV and the development of LBP. Long term exposure to WBV which results from operating engines and vehicles can cause early accelerated degenerative spine diseases leading to back pain (National Institute of Occupational Safety and Health 1997; Johanning, 2000)

2.4.3 Repetitive movement

Behrens et al (1994) defined repetitive movement as repeatedly lifting, pushing, pulling, twisting, reaching or bending. According to various reports, performing the same task repeatedly may put stress on the muscles, tendons and joints which will contribute to the development of MSDs such as carpal tunnel syndrome (Putz-Anderson, 1997; Stock et al 2005).

Most heavy equipment operating tasks are repetitive in nature and they are controlled by hourly or daily production targets and/or work processes and when combined with other risks factors such as awkward postures can lead to the development of MSDs (Middleworth, 2016). Repetitive motion can become worse if performed at a high rate over a long duration, when there is not enough rest periods to allow the stressed muscles or the body parts to recover, where there are high forces or awkward postures involved and when the muscles or the body part is not accustomed to the task (Workplace Guidelines for the Prevention of Musculoskeletal injuries 2002; Stock et al 2005).

Furthermore, Takala (2002) explains that repetitive motion is likely to result in muscle fatigue especially in the shoulder muscles which leads to lots of shoulder complaints among operators of heavy equipment. Finally a study done by Ghaffari et al (2006) shows that repetitive work positions contribute to MSDs especially low back pain.

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2.4.4 Psychological factors

Numerous studies have shown that psychosocial factors can also contribute to the development of WMSDs. (Smith et al 1994 and ILO, 1986) defined psychosocial work factors as the nonphysical aspects of work environment that deals with work roles, pressure and workplace relationships that can lead to stress in individuals. Leelavathy, Raju and Gokul, (2013) also defined the psychosocial aspect of work as the nonspecific and nonphysical elements of work environment which can be attributable mostly, to the workers attitude and stress.

Psychosocial risk factors include low social support at the work place, high job demands, low job satisfaction, low job control and low supervisor support. Crane and forklift operators are exposed to psychosocial factors such as high demand, low control and low job satisfaction which contribute greatly to MSDs such as low back pain in this category of workers (Smedley et al 2014). Furthermore, Eatough et al (2012) indicated that not having controls over a job, low job satisfaction and working in an unsafe environment increases heavy equipment operators stress level which may result in MSDs of the wrist, hand, shoulders and low back pain.

Johanning (2000), stated that certain non-physical factors such as perception of intensified workloads, limited job control and job satisfaction, low social support and low morale can all contribute to the development of MSDs. Lastly, heavy equipment operators at the ports suffer from job strain because focusing on the tasks is compulsory and working with high precision is very crucial for every single movement which can lead to psychosocial problems resulting to MSDs.

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2.4.5 Duration of exposure

Various studies have shown that the duration of exposure to the risk factors of MSD influences the development of the disease. A study conducted by Zimmerman (1997), for example showed that the longer the time of employment as a heavy equipment operator the higher the rate of musculoskeletal injury case reports and the frequency of visits to medical facilities by heavy equipment operating employees.

Also, the greater the intensity, duration and frequency of exposure to risk factors at work, the greater the risk of developing WMSDs, and reducing the exposure to risk factors also reduces MSDs complaints.

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CHAPTER THREE

3.0 METHODOLOGY

3.1 Type of Study

The study design was cross-sectional. Cross-sectional study determines both the exposure and the disease outcome simultaneously for each participant and it can also be viewed as a snapshot of the population at a certain point in time (Gordis, 2008). In a cross-sectional study, the population sample is selected, information will be obtained simultaneously from the participants about the exposure and the outcome. Cross-sectional study was appropriate for this research because the study was interested to assess the possible relationship between operating a heavy equipment (exposure) and the occurance of MSDs (the disease).

3.2 Study Site

3.2.1 History of Tema port, Ghana

The port of Tema is located on the east coast of Ghana, twenty-one nautical miles off the north-east coast of the capital city, Accra, and is the larger of the two sea ports in Ghana. The Tema Port is situated on the Greenwich meridian and latitude 5.4 degrees north of the equator. The port covers a land area of 3.47 million square meters within which there are Inland Clearance Depots (ICDs), warehouses, transport and haulage companies and various service centers.

The port serves as a loading and unloading site for cargos from many countries and serves as a transit for cargos bound for neighbouring countries such as Niger, Mali, Benin and Burkina Faso (Shipping Review, 2015). Tema ports is the main import ports for Ghana and an export port for East of Ghana (SAL Consult Ltd, 2015). In 2006, the ports of Tema handled 7 million Weights of imports and 1.1 million Weights of exports on 1994 vessels Tema Port has the capacity to store containers and cargos (World port source, 2015). In 2011, Tema ports

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handled 80% of cargos which carried pharmaceuticals, medical supplies, processed foods and beverages and medical supplies (Shipping Review, 2015). Figure 3 below shows the Map of Tema Port.

Figure 3: Map of Tema Port (retrieved from "www.GPHA.com 2006" on June 15, 2016**)**

The Ghana Ports and Harbours Authority (GPHA), was established in 1986 as a statutory corporation under the PNDC Law 160 to control the ports of Tema and the ports of Takoradi and it is responsible for planning, managing, expanding and maintaining the seaports of Ghana (SAL Consult Ltd, 2015).

For the operation or provision of any port facility which the Authority is empowered to operate or provide. Appointing, licensing and regulating stevedores, master porters to operate

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in the container terminals; vii. Establishing pilotage districts and directing that pilotage shall be compulsory in any such district, determine the pilot (including Authority pilots) to operate in such districts, license pilots for work in such districts and establish pilotage boards and specify their duties including the duty of inquiring into the conduct of pilots; Prescribe rates, charges and dues for service provided by the Authority or specify the persons liable to pay such rates, charges and dues. GPHA provides the following main activities; Offers pilotage services; Supervises stevedoring and container services, fire prevention and the protection of life; outsourcing construction, supplies, manufacturing and maintenance or repair works at the port; Appointing, licensing and regulating stevedores; Prescribe rates, charges and dues for service provided by the Authority.

3.2.2 Study area

The study area was at the logistics department inside the port of Tema. It is a very restricted area for security reasons. This is where the heavy equipment operators gather during change of shift before being discharged to their various post. Figure 4 below shows loading and unloading Container and Merchant ships.

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Figure 4: Showing heavy equipment operators loading and offloading container ships and merchant ships

3.3 Study Variables

3.3.1 Dependent variables

Musculoskeletal Disorders heavy equipment operators are likely to encounter at work such as lower/upper back pain, neck/shoulder pain, arms/wrist pain, leg pain.

3.3.2 Independent variables

The independent variables include:

- Whole-body vibration
- Awkward Postures
- Sitting hours
- Working hours
- Psychosocial factors

3.3.3 Confounding factors

The confounding factors of the study include:

- Age of the operators

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- Highest level of education
- Type of machinery operated in Weights

FIGURE 5: Showing examples of heavy loads being conveyed by heavy equipment operators (Retrieved from "www.ghanaports.gov.gh" on February 5, 2016**)**

3.4 Study Population

Target participants for this study were the heavy equipment operators who were able to answer questions and the results of the survey applies to them. On that note, heavy equipment operators at GPHA at the Tema port stevedoring were the target population. There are 250 heavy equipment operators that are directly under GPHA.

3.5 Sample Population

The sample population comprised 250 heavy equipment operators at the Ghana Ports and Harbour Authority (GPHA), Tema. Each of these individuals had an equal chance of being

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chosen through a simple random sampling procedures. Simple random sampling is a sampling method where every individual in the target population have the opportunity to be included in the sample (Kitchenham, 2002).

3.6 Sample Size Calculation

Using a sample population of 250 workers, Glen et al (1992) sample size calculation formula (below) was used to calculate the sample size which generated the result of 152 respondents. Questionnaires were therefore administered to a total of 152 randomly selected heavy equipment operators.

$$n = P\{1\text{-}P\}/\{A^2/Z^2 + [P(1\text{-}P)/N]\}$$

Where:
n = Sample size required
N = Total number of heavy equipment operators at GPHA (250)
P = Estimated proportion of people with MSDs (0.5)
A = Precision desired around P to be estimated, (0.05)
Z = Confidence level critical value (1.96 for 95% confidence)

$$n = 0.5\{1\text{-}0.5\}/\{(0.05^2/1.96^2) + [0.5(1\text{-}0.5)/250]\} = 152$$

3.7 Data Collection

3.7.1 Questionnaire validity and reliability

Sekaran (2000) defines a questionnaire as a pre-formulated written set of questions which enables respondents to record their answers. Most studies done in order to determine exposures that causes MSDs such as back disorders, neck and shoulder problems requires some type of questionnaire which will help the participant to respond appropriately (Joubert, 2007). A questionnaire is an efficient way of collecting data because it helps the researcher to know exactly what is required and how variables of interest can be measured (Sekaran, 2000).

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Questionnaire was the main tool for data collection and in this study, Nordic Musculoskeletal Questionnaire was distributed among all study participants. Palmer et al (1999) stated that the Nordic Musculoskeletal Questionnaire (NMQ) is a validated survey instrument usually used to assess the prevalence of workplace musculoskeletal symptoms

According to Kuorinka et al (1987) the development of the NMQ was funded by the Nordic Council of Ministers. The aim of the NMQ was to develop and test a standardized questionnaire methodology that will help compare low back, neck, shoulder and general complaints for use in epidemiology studies (Crawford, 2007). The validity of the NMQ was tested against clinical history and found a range of 0 to 20% disagreement, and in respect of this, concluded that this questionnaire was acceptable as a screening tool for musculoskeletal diseases (Kuorinka et al 1987).

The validity of Nordic-style questionnaire was assessed and it was concluded that it could be considered as a useful tool for the surveillance of work-related musculoskeletal disorders (Descatha et al 2007). All the three studies (Kuorinka et al. 1987, Crawford, 2007, Descatha et al 2007) reported that the NMQ is useful and valid as a screening and surveillance tool for musculoskeletal diseases. However, medical examination will be needed in order to make a clinical diagnosis. The foregoing reports, therefore, evidence the validation of the NMQ for screening of musculoskeletal diseases.

3.7.2 Questionnaire structure

NMQ was used to assess MSDs among heavy equipment operators at the port of Tema. Each participant provided the following information on the questionnaire. Age in years (21-30, 31-40, 41-50, 51-55). Gender (male, female); level of education (no formal education, primary, junior high school, senior high school and tertiary); type of machine operated (3-10 Weights, 20-25 Weights, 30-36 Weights, 41-45 Weights, 50 Weights 200 Weights); number of years on

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the current job (less than a year, 1-3 years, 4-10 years, 11-20 years, 20 years and above); if the operators are currently experiencing any pain and should indicate by the body part; operators indicated which part of their body vibrates while working; what postures do they usually assume while working (sitting upright, bending while sitting, leaning forward while sitting) and the number of hours worked during the day (8 hours, 12 hours). Self-reported musculoskeletal symptoms were evaluated where the participants indicated yes/no to any pain or discomfort experienced in the last 12 months.

Body regions used in the NMQ were neck, shoulders, elbow, hands, upper back, lower back, hips/thighs, knees and ankles. There is a section on the questionnaire which stated whether any of the symptoms experienced had prevented the operators from going to work or had interrupted with their going to work. The survey respondents' background information collected was crossed tabulated using the above information. The results were summarized in tables for discussion and conclusion.

3.7.3 Sources of data

The two main principles of data types are the primary and the secondary. Data for this study was collected from both the primary and the secondary sources. Primary data was collected directly from the heavy equipment operators at the port of Tema where Nordic Standardized Questionnaires and self-administered questionnaires were administered. Secondary data were from the University of Ghana libraries, books from other sources, online articles, journals, reports, were used.

3.7.4 Quality control

The questionnaires were administered inside the port of Tema at the logistics department where the heavy equipment operators gather for their morning and evening

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devotions before embarking on their daily duties of loading and unloading vessels. No problems were encountered during the administration of the questionnaires.

3.8 Data Processing and Analysis

All questionnaires received were checked for completion and to identify any errors or omissions on them. All questionnaires were entered in IBM SPSS 2015. Statistical analysis was carried out using Statistical Package for Social Sciences (SPSS) version 2015.

3.9 Ethical Consideration

Approval was sought from the Ghana Health Service (GHS) Ethical Review Committee (ERC). Permission was sought from GPHA management. Informed consent was sought from the heavy equipment operators. The workers were allowed to ask questions or seek clarification. Confidentiality was ensured. Participation in the study was entirely voluntary and that declining to participate, answer a question question or terminate the interview did not incur any negative consequences.

The participants were informed that they could withdraw from the study anytime they chose to do so. All information regarding the study was locked up at a safe place to ensure confidentiality of information. The principle investigator and the supervisors were the only persons that had access to the collected data. There were no potential risks in the study. There was no conflict of interest. The findings from the study could help management to make decisions that will help prevent or reduce musculoskeletal problems among the staff.

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CHAPTER FOUR

4.0 RESULTS OF THE STUDY

4.1 Introduction

The main objective of this study is to assess musculoskeletal disorders among heavy equipment operators at the Tema port. The methodology used for the study was discussed in the previous chapter, the results of the study are presented in this chapter.

The researcher in an attempt to collect data relevant to the study sampled 152 heavy equipment operators at the port of Tema. Their demographic data and their exposure to risk factors contributing to MSDs at the workplace was ascertained using an adapted Nordic musculoskeletal questionnaires. However, only 100 of the questionnaires were filled and returned. As a result, the analysis, the findings and the conclusions of the results were based on the 100 responses. All the 100 respondents sampled for the study were males.

Table 1 below summarizes the demographic characteristic of heavy equipment operators who responded to the research questions asked. As shown, 100 males of ages from 21 to 55 years participated in the study. Individuals of ages from 31-40 years were the largest majority (63%) while respondents of ages between 51-55 years formed the minority (1%). The results also show a majority (53%) of the respondents had junior high school (JHS) education, followed by Senior High School (SHS) grandaunts who constituted 35% of the respondents and individuals with no formal education were the minority (2%).

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Table 1: Demographic Characteristics of Heavy Equipment Operators

Characteristics	Frequency N=100	Percentage (%)
Gender		
Males	100	100
Age (years)		
21-30yrs	23	23.0
31-40yrs	63	63.0
41-50yrs	13	13.0
51-55yrs	1	1.0
Highest level of education		
No formal education	2	2.0
Primary	10	10.0
JHS	53	53.0
SHS	35	35.0

4.2 Weights of Machines Used by Heavy Equipment Operators

When the respondents were asked about the heavy duty machine that they operate in order to perform their task, 30% reported operating 3-10Weights, (29%) reported operating 20-25 Weights, (37%) operated 30-36 Weights, most of the respondents (54%) operated 41-45 Weights, (13%) operated 50 Weights, (9%) operated 200 Weights, and lastly, only (1%) of the respondent operated a machine that weighs more than 200 Weights. This indicates that majority of the heavy duty equipment operators operate machines between 41-50 Weights.

Table 2 below illustrates the relationship established between the Weights of machines used by operators in relation to musculoskeletal disorder. The logistic regression results revealed that operators who operate between 41-50 Weights machines was statistically significant (p= 0.001) and are about 2.9 times more likely to develop musculoskeletal disorders compared to those operating below.

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Table 2: Association of weights of machines used by heavy equipment operators with Musculoskeletal Disorders

Variable	Adjusted Regression coefficient	SE	p-value	Odds Ratio	95% C.I for Odds Ratio	
					Lower	Upper
3-10Weights	0.214	0.566	0.747	0.833	0.275	2.527
10-25Weights	0.134	0.548	0.806	0.874	0.299	2.558
30-36Weights	0.143	0.519	0.782	0.866	0.314	2.395
41-50Weights	1.591	0.488	0.001*	2.907	1.887	5.45
200Weights	0.207	0.771	0.789	1.230	0.271	5.571

***significant-statistically**

4.3 Distribution of length of time on the job among heavy equipment operators

The analysis revealed that majority of the operators have been working at their current job as 54% reported working at the port of Tema for 4-10yrs, (33%) had worked for 1-3yrs, (9%) for 11-20yrs and only (4%) had worked more than 20years. Table 3 below represents the number of years worked by the operators at the time of the interview.

Table 3: Distribution of length of time on the job among heavy equipment operators

Variables	Frequency	Percentages (%)
Number of years		
1-3yrs	33	33
4-10yrs	54	54
11-20yrs	9	9
>20yrs	4	4

4.4 Musculoskeletal Disorder Symptoms among Respondents

The musculoskeletal disorder symptoms of the respondents were ascertained in order to better understand their risk of exposure to their working conditions. When the respondents were asked if they were experiencing pain, 65% reported yes and 35% reported no. Respondents who reported yes to experiencing pain were further asked to indicate which part of their body they were experiencing the pain, neck pain represented (35%) followed by waist

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pain (25%) those were the two highest reported. 5% reported of back pain while 4% reported having pain in their entire body, waist and back, waist and neck respectively

4.5 Vibration of Body by Heavy Machinery During Operation

Respondents were asked whether any part of their body vibrates while operating an equipment 60% answered in the affirmative and 40% reported no and they were further asked to indicate the part of their body where they experience vibrations and majority representing 72% indicated the entire body, 20% reported they felt vibration in the waist, 4% reported in the legs while only 1% reported vibration in the back while operating a heavy equipment.

4.6 Postures Assumed During Work

When the respondents were asked about the postures usually assumed during work, 72% reported they usually sit upright while performing their task and 28% said they do not assume upright position when performing a task. Respondents were asked whether they bend in a sitting position whiling operating equipment and 33% answered in the affirmative, 67% however said no. 29% of the heavy equipment operators lean forward whilst sitting in the course of their work. Table 4 below represents the postures usually assumed during work.

Table 4: Frequency distribution of postures assumed during work by heavy equipment operators

Variables	Frequency	Percentage (%)
Sitting upright		
Yes	72	72.0
No	28	28.0
Bending white sitting		
Yes	33	33.0
No	67	67.0
Leaning forward while sitting		
Yes	29	29.0
No	71	71.0

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4.7 Distribution of Musculoskeletal Disorders among Respondents

Table 5 below summarizes the results of assessment of musculoskeletal diseases among the respondents. When the respondents were asked the number of hours they worked in a day, most of them representing 91% reported working for 12 hours, while the remaining 9% worked 8 hours in a day. Also, 42% of the respondents reported having trouble with their neck which prevented them from performing their regular task while 58% did not have any problem with their neck. The results also shows that 38% had problems with their shoulders while 62 % did not have any problems with their shoulders. With reference to lower back pain, however, 55% responded yes to having the problem while the lowest reported body region with problems was the elbows 33%.

Respondents were asked if they had any trouble in any part of their bodies during the past 12 months, neck and upper back were reported 51% which was the highest respectively as a problem during the past 12 months, followed by hips/thighs and ankles/feet at 47% respectively and the lowest reported 37% were the knees.

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Table 5 Distribution of musculoskeletal disorders among heavy equipment operators

Activity	Variable	Frequency count(n) N=100	Percentage (%)
Unable to carry out normal activities such as work in the past 12 months because of symptoms	Neck	42	42.0
	Shoulders	38	38.0
	Upper back	40	40.0
	Elbows	33	33.0
	Hand	44	44.0
	Lower back	55	55.0
	Hips/Thighs	51	51.0
	Knees	44	44.0
	Ankles/Feet	39	39.0
Experience of symptoms such as pains in the past 12 months	Neck	51	51.0
	Shoulders	41	41.0
	Upper back	51	51.0
	Elbows	45	45.0
	Hand	43	43.0
	Lower back	46	46.0
	Hips/Thighs	47	47.0
	Knees	37	37.0
	Ankles/Feet	47	47.0
Seeing a physician in the past 12 months because of severe body symptoms	Neck	29	29.0
	Shoulders	24	24.0
	Upper back	32	32.0
	Elbows	34	34.0
	Hand	24	24.0
	Lower back	43	43.0
	Hips/Thighs	22	22.0
	Knees	26	26.0
	Ankles/Feet	26	26.0

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4.8 Association of Variables with Musculoskeletal Disorders

Relationship between the age of the participants, length of employment and the number of hours they work per day in relation to musculoskeletal disorder of the heavy equipment operator was examined. The regression results revealed that the period of employment of the heavy equipment operators and the number of hours the workers work per day significantly influenced the musculoskeletal disorder at 5% level of significance($P < 0.05$). However, the age of the heavy equipment operators was not statistically significant to influence musculoskeletal disorder. Per the results obtained it was observed that majority representing 91% work for 12 hrs a day whilst the reaming 9% work for 8 hrs a day.

An adjusted R^2 given from the regression analysis was 0.68. This is approximately 68%. Statistically this is a good fit indicating that the age, period of employment and number of hours worked per day of the workers contributes to 68% of the variation in musculoskeletal disorder of the heavy equipment operators. Table 6 illustrates the results of the regression analysis.

Table 6: Association of Variables with Musculoskeletal Disorders

Variable	Adjusted regression coefficient	SE	p-value	Odds Ratio	95% CI for Odds Ratio	
					Lower	Upper
Age	-0.770	0.391	0.782	0.463	0.215	0.996
Length of time of employment	0.084	0.306	0.042*	0.919	0.505	1.674
Number of work hours	0.382	0.821	0.021*	1.466	0.293	1.333

***significant at P≤0.05 Adjusted R^2=0.68**

4.9 Association of Musculoskeletal Disorders with Operation of Heavy Equipment

Table 7 below, illustrates the association of various musculoskeletal disorders with operation of heavy equipment. A binary logistic regression of the relationship between

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musculoskeletal disorder and heavy equipment operation revealed that, neck pains, upper back pains, hand pains, lower back pains and Hips/Thighs pains were significantly associated with the exposure of the heavy equipment operators to work activities in the multivariate variables ($p < 0.05$). The odds of suffering from neck pain was 3.9 times higher among the participants (Adjusted OR, 3.913 [95 % CI, 0.751-1.373], $p = 0.015$). The odds of developing symptoms of upper back pain was also 2.5 times likely among the workers (Adjusted OR, 2.5 [95 % CI, 0.199-3.066], $p = 0.003$). Similarly the odds of developing hand pain (Adjusted OR, 2.0 [95 % CI, 0.320-1.805], $p = 0.02$), lower back pain (Adjusted OR, 1.36 [95 % CI, 0.144-3.825], $p = 0.048$) and Hips/Thighs pain (Adjusted OR, 1.38 [95 % CI, 0.192-2.280], $p = 0.002$) were all significantly associated with the exposure to the work of the heavy equipment operators at the port of Tema. Table 7 shows the regression results of the association between the musculoskeletal disorder and health risk of the studied participants.

Table 7: Association of musculoskeletal disorders with operation of heavy equipment

Variable	Adjusted regression coefficient	SE	p-value	Odds Ratio	95% C.I for Odds Ratio	
					Lower	Upper
Neck	1.364	0.842	0.015*	3.913	0.751	1.379
Shoulders	-2.632	1.644	0.109	0.072	0.003	1.806
Upper back	1.510	1.595	0.003*	2.526	0.199	3.066
Elbows	-1.048	0.824	0.998	0.024	0.014	1.424
Hand	0.705	0.941	0.021*	2.023	0.320	1.805
Lower back	0.307	1.145	0.048*	1.360	0.144	3.825
Hips	2.126	0.499	0.002*	1.381	0.152	2.280
Knees	-0.966	0.877	0.270	0.380	0.068	2.121
Ankles	0.858	0.957	0.370	2.357	0.361	3.378

Statistically significant at P≤0.05

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CHAPTER FIVE

5.0 DISCUSSIONS

This chapter presents the relevant findings and discussions of the study. The purpose of this thesis was to assess musculoskeletal disorders among heavy equipment operators at the port of Tema in order to find the specific contributing factors and to suggest preventive measures. The discussion is done in line of the objectives of the study.

Significant associations were found between the occurrence of MSDs and the length of employment, number of hours worked per day and the type of machines operated. The results also revealed that, neck pains, upper back pains, hand pains, lower back pains and Hips/Thighs pains were significantly associated statistically with the exposure of the heavy equipment operators work activities. However, MSDs were not statistically significant association with the heavy equipment operator's demographic characteristics such as age and their level of education. The results found no statistically significant association between risk factors exposed to at the work environment and the occurrence of MSDs such as shoulders, elbows, knees and ankles.

5.1 Different types of MSDs and their association to operating heavy equipment

5.1.1 Prevalence of neck pains among heavy equipment operators

The first objective of the study was to determine the different types of MSDs suffered by heavy equipment operators. This study found that 65% of the operators were experiencing pain at the time of the interview while 35% were not experiencing any pain. Brebbia (2012), stated that the results of a musculoskeletal discomfort survey found that heavy equipment such as mobile crane operators do suffer from neck, hip, upper and lower back problems. Maiti,et al

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(2014) also confirms that cranes height contributes mostly to complaints of MSDs of the lower back, neck and shoulder areas.

Also, an overall prevalence (51%) of neck pain among the workers was found to be slightly associated with MSD ($p<0.05$). This findings with the results of other studies Health and Safety Executives [HSE] (2006; Binder, 2007) which also reported higher rates of neck injuries and pains among heavy equipment operators than other MSDs. Also, these findings therefore confirm that during work by heavy equipment operators, the neck was subjected to awkward postures more than other parts of the body (Ariens et al 2000).

5.1.2 Prevalence of back pains among heavy equipment operators

From the results, the prevalent of upper back pain was also found to be (51%) MSDs among heavy equipment operators. Statistically significant association was found between the activities that the operators were exposed to and the occurrence of upper back pain. The results revealed that machine operators are about 2.5 times more likely to develop lower back pain and 1.7 times likely to develop higher upper back pain. Waters et al (2008) for example reported that the association observed could be attributed to the fact that during operation of the heavy equipment the workers spend most of the time sitting which exert a lot of strain on the back. Indeed, this deduction was confirmed by Choobineh et al (2007) who indicated that the high rates of back MSDs problems among heavy equipment operators can be attributed to the awkward postures they assumed over a prolonged period of time while operating the equipment.

5.1.3 Prevalence of hand pains among heavy equipment operators

A 43% prevalence of hand pains was recorded among the participants, with a 2 times likelihood (ODDs ratio = 2.0) than non- operators. During work, heavy equipment operators

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use their hands to carry out various strenuous tasks which cause the hands to be subjected to awkward posture, vibration and frequent use which are risk factors for musculoskeletal disease (Malehaire et al 1998). It is therefore not surprising that hand pains had the 3rd highest prevalence for MSDs amongst the workers.

5.1.4 Prevalence of hips/ thighs pains among heavy equipment operators

The results showed that the prevalence of hips/ thighs pains among the heavy machine operators was significantly associated statistically ($P<0.05$) with the risk factors of MSDs such as length of time of operation of the machine and weight or heaviness of the machine, between 41-50 tons. The results also showed that operators of heavy equipment were 1.3 times more likely to develop hips/ thighs pains than non-operators. These results were in agreement with findings from other studies (Brebbia, 2012; Johanning, 2000), which also indicated that pains of the hips and thighs were among the MSDs mostly observed among heavy machine operators compared to non-operators.

5.2 Number of Hours Worked Per Session and Duration of Employment as a Heavy Machine Operator

Even though the study could not associate age of employee with development of MSDs it showed that the length of time spent per session on the job and the number of years of employment as a heavy equipment operator was statistically significant associated ($P<0.05$) with development of the condition. The likely reason for this observation could be that the development of MSD is dependent on the intensity of exposure to the risk factors, such that the longer the time spent on the job would cause the cumulative exposure to the risk factors to increase, which in turn, would cause the destructive health effect to build up leading to the development of MSD. Indeed, this explanation is supported by reports from studies conducted by other researchers (Dembe et al., 2005; Smith et al., 2005; HSG, 2000), which indicated that

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working overtime and for several years operating a heavy machinery are important factors that lead to the development of MSDs among individuals.

5.3 Limitations of the Study

This study was, however, limited by the fact that there were no medical examinations conducted in the course of the study to ascertain the veracity or genuineness of the answers given to the various questions by the respondents. This limitation could lead to under or over estimation of the prevalence of the musculoskeletal conditions among the heavy machine operators.

Also, the study sample was not balanced, relative to gender, as there were no female heavy machine operators at the Ghana Ports and Harbour Authority (GPHA).

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CHAPTER SIX

6.0 CONCLUSIONS

In conclusion, the study showed that most heavy equipment operators of the GPHA are exposed to various work related hazards, such as awkward posture, whole body vibrations, prolonged sitting and repetitive movement of body parts which contribute towards development of MSDs. Also, the study showed that a combination of risk factors work together to lead to the development of MSDs.

Furthermore, the study showed that the most prevalent musculoskeletal disorders among heavy equipment operators of the GPHA, were neck pains, back pains, hand pains and hips/ thighs pains ($P<0.05$). Pains in the shoulder, elbow, knees and ankles, even though were observed among the heavy machine operators were not significantly associated with risk factors of the disease.

Finally, according to the study, whilst length of time as a heavy machine operator and the operation of heavy machines with weights between 41-50 tons were significantly associated ($P<0.05$) with development of MSDs, the age of heavy machine operator was not ($P>0.05$).

6.1 Recommendations

In view of the findings and conclusions, the following recommendations are made to GPHA for consideration which will help to prevent or reduce workplace risk factors contributing to MSDs**.**

1. The Managers must have an open door policy where their employees can freely have an open conversation about how they are affected by MSDs and how it has impacted their lives.
2. Health programs must be organized for the heavy equipment operators in order to reduce their risk of developing musculoskeletal disorders.

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3. Heavy equipment operators must rest between shifts and their work must be scheduled in such a way that it does not affect their health and general well-being.
4. Management is recommended to have polices or documents outlining jobs or various tasks for specific MSDs injuries and this document need to be updated periodically.

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APPENDICES

APPENDIX I: QUESTIONNAIRE

Dear Participant,

We are conducting a study at the School of Public Health, University of Ghana and would like to ask for your help. This study is related to your current job and will give you helpful information regarding decision makings on your health. May you kindly complete this questionnaire on your musculoskeletal health and medical history. You may leave any questions that you don't feel comfortable answering. All information provided will be kept confidential.

Please feel free to contact the person listed below should you have any questions regarding the study.

Thank you for cooperation in this research project.

Contact for more information:

Veronica Ama Asangbah (Student)

Phone number: 0200308135

Email: vfoli@yahoo.com

University of Ghana, School of Public Health, MSc. Occupational Hygiene.

Research Topic: Assessment of musculoskeletal disorders among heavy equipment operators at the Ghana Ports and Harbours Authority in Tema.

Questionnaire-General Information

1. Please check your appropriate age range: □ 21-30yrs □ 31-40yrs □ 41-50yrs □ 51-55yrs
2. What is your gender? □ Male □Female
3. What is your level of education? □ No formal education □ Primary □ JHS □SHS □ Tertiary

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4. What machine do you operate? □ 3-10 Weights □ 20-25Weights 30-36Weights 41-45Weights

□ 50Weights □200Weights

5. How long have you been working at your current job? □ 1-3yrs □ 3-10 years □ 11-20yrs □ 20yrs and above

6. Are you currently experiencing any pain? □ Yes □No

6a. If yes, in which part of your body? .....

7. Does any part of your body vibrate while operating an equipment? □ Yes □No

7a. If yes, which part of the body vibrates? .....

8. What posture(s) do you usually assume during work? □ Sitting upright □ Bending while sitting □ Leaning forward while sitting

9. How many hours do you work in a day? 8 hours □ 12 hours □

Adapted Nordic Musculoskeletal questionnaire

Please answer by checking the appropriate box.

	Have you been unable to carry out normal activities (e.g. work) in the past 12 months because of trouble in the:	**Have you at any time during the past 12 months had trouble (such as pain, numbness) in the:**	**Have you seen a physician in the past 12 months because of trouble in the:**
NECK	**□No □Yes**	**□No □Yes**	**□No □Yes**
SHOULDERS	**□No □Yes**	**□No □Yes**	**□No □Yes**
UPPER BACK	**□No □Yes**	**□No □Yes**	**□No □Yes**
ELBOWS	**□No □Yes**	**□No □Yes**	**□No □Yes**

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HAND	**□No**	**□Yes**	**□No**	**□Yes**	**□No**	**□Yes**
LOWER BACK	**□No**	**□Yes**	**□No**	**□Yes**	**□No**	**□Yes**
HIPS/THIGHS	**□No**	**□Yes**	**□No**	**□Yes**	**□No**	**□Yes**
KNEES	**□No**	**□Yes**	**□No**	**□Yes**	**□No**	**□Yes**
ANKLES/FEET	**□No**	**□Yes**	**□No**	**□Yes**	**□No**	**□Yes**

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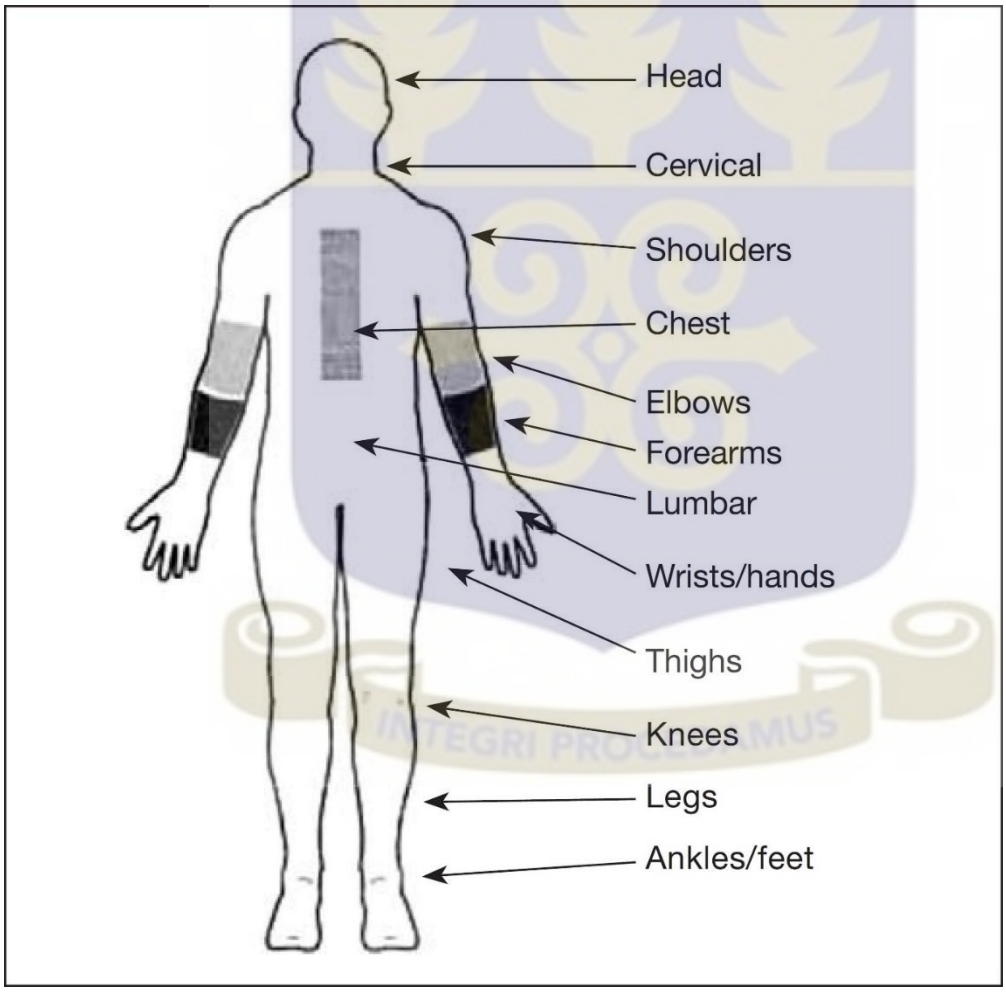

Thank you very much for participating, we appreciate your cooperation. This research will help identify musculoskeletal injuries that are associated with your work and will help prevent certain injuries at work.

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APPENDIX II: INFORMED CONSENT FORM

CONSENT FORM FOR THE STUDY ENTITLED:
ASSESSMENT OF MUSCULOSKELTAL DISORDERS (MSDs) AMONG HEAVY EQUIPMENT OPERATORS AT THE GHANA PORTS AND HABOURS AUTHORITY
FOR SUBJECTS 18 YEARS AND ABOVE.

Information: to be read and translated to adults in their own mother tongue if necessary)

Dear Sir/Madam,

I invite you to take part in a study sponsored by the School of Public Health, College of Health Sciences, University of Ghana, Legon. It is important that you understand several general principles that apply to everyone who takes part in this study:

1. Participation in the study is entirely voluntary.
2. Personal benefit to you may not result from taking part in the study, but knowledge gained may benefit others.
3. You may withdraw from the study at any time.
4. Withdrawal from the study may not cause you to lose any services you are entitled to in this organization.

The musculoskeletal system consists of the bones, muscles, ligaments and tendons. Musculoskeletal Disorders, (MSDs) are injuries to the joints, muscles, tendons, nerves and ligaments. Examples of such disorders are carpal tunnel syndrome, ligaments sprain, muscle strain, tendonitis, tension neck syndrome and radial tunnel syndrome. The operators of heavy equipment often sit for prolonged hours during which they assume awkward and static postures carrying out repetitive operations of equipment, and causing vibrations throughout the body which may result in the development of MSDs. The main purpose of this study is to assess the prevalence of MSDs among heavy equipment operators at the GPHA and recommend preventive measures. You may choose not to participate in the study. If you agree to participate

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in this study, you will be administered a questionnaire. The participants will be allowed to ask questions or seek clarification. Confidentiality of the participants will be strictly maintained to ensure privacy. The risk associated with this study is minimal. The anticipated risk to the participant is the 15-20 minutes of the time that he/she will use in filling out the questionnaire. Questionnaire administration will not involve any invasive procedures. Participating in the study is entirely voluntary and that declining to participate in the study, answer a question or terminate the interview will not incur any negative consequences. If you wish to withdraw from this study, you may do so at any time. All information regarding the study will be locked up at a safe place to ensure confidentiality of information. The findings of this study will not be shared with anybody except the study investigators and management. There will not be any monetary payment to the participants. The findings from the study will help management to make decisions that will help prevent musculoskeletal problems among the staff. I do not anticipate or foresee any conflict of interest.

Do you have any questions about participating in this study? Any questions or concerns about this study must be directed to Veronica Asangbah at the School of Public Health, College of Health Sciences, University of Ghana, Legon.

Yours Sincerely,

Mrs. Veronica Asangbah

Researcher Tel: 0200308135

If you agree to participate in this study, please put your signature or thumbprint below.

Adult Signature or Thumbprint	*Investigator Signature*	*Date*

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Volunteer agreement

The risks and the benefits of this research are stated above. Musculoskeletal disorders among heavy equipment operators has been explained to me. Opportunity has been given to me to ask questions and answers have been provided to my satisfaction. I hereby agree to participate in this research as a volunteer.

....
Date Signature of the volunteer

Volunteers that are unable to read can have a witness to sign on their behalf below.

The benefits of the research has been well explained to the volunteer in my presence and he/she wants to go ahead and participate.

....
Date Signature of witness

I certify that the benefits and the risk involved in this research has been well explained to the participants.

....
Date Signature of Principal Investigator

Once again, thank you.