

**Prevalence of and risk factors for work-related musculoskeletal
injuries (WMSIs) amongst underground mine workers in Kitwe,
Zambia**

BY

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degree of Masters of Science in the Department of Physiotherapy,
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Ergonomic

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ABSTRACT

Work-related musculoskeletal injuries are common in both developed and third world countries. Although estimates are not available in third world countries like Zambia, especially in the mining industry, most researchers agree that exposure to the combination of work place risk factors is a major contributor to these injuries. These risk factors include personal, ergonomic and psychosocial factors like age, forceful exertions and high workload. However, the most important occupational risk factors are not known. The aim of the study was to determine the prevalence of and risk factors contributing to work-related musculoskeletal injuries amongst underground mine workers in Kitwe, Zambia. A cross sectional retrospective quantitative study design was used. A stratified random sampling method according to mining work activity type was used to obtain the sample of this study. The random order was determined by using the random number table to select a sample of 500 mine workers from 7 main job types namely mechanics, electricians, miners, loader drivers, locomotive drivers, supervisory and "others". A structured self-administered questionnaire was used to gather information from the mine workers. The questionnaire was developed from existing surveys of occupational injury and risk factors. A response rate of 40.4% (202) was obtained. The collected data from mine workers were captured and analyzed by means of the statistical package for social sciences (SPSS), version 15.0. The associations between variables were evaluated by means of the chi-square test and 5% level of significance was used. ANOVA was used to determine whether differences exist between groups. The results were displayed

using tables, as well as bar and pie charts. The study revealed 42.6% of injury prevalence. The back was the most affected body part (44.2%) followed by the wrist/hand (40.7%). Generally, the mechanics and the supervisors reported the highest injury frequencies. Factors consistently reported by workers included poor postures, repetitive work, heavy lifting, working very fast and working very hard. There were significant associations ($p < 0.05$) between working with the back bent, forceful grip, grasping objects with wrist bent and back and wrist/hand injuries respectively. The study also found significant associations ($p < 0.05$) between working very fast, insufficient time to do work, level of training and injury. There were no significant associations between age, experience, occupation and injury. However, ANOVA indicated statistically significant differences ($p < 0.05$) in mean "injury" between mine workers in all age groups. Post-hoc analysis using Scheffe's test also indicated significant differences ($p < 0.05$) in mean "injury" between mine workers with more than 10 years of work experience and those who had 5-10 or less than 5 years of experience. The results of this study highlight a number of important factors that must be addressed in order to combat work-related musculoskeletal injuries amongst underground mine workers. These include heavy lifting, repetitive work and poor posture. Factors to be addressed also include work load and high speed of work. The majority of mine workers cited replacement of old machinery with modern ones and increasing the workforce as important preventative measures.

DECLARATION

I hereby declare that: **“Prevalence of and risk-factors for work-related musculoskeletal injuries (WMSIs) amongst underground mine workers in Kitwe, Zambia”**, is my own work, that it has not been submitted, or part of it, for any degree or examination in any other university, and that all the sources I have used or quoted have been indicated and acknowledged by means of complete references.

Signature:



Richard Kunda
November 2008
UNIVERSITY of the
WESTERN CAPE

Witness:

Prof. José M.FRANTZ

Witness:

Ms Farhana Karachi

DEDICATION

To my mother late LOVENESS NSWANA and my father late TEDDY KUNDA

To the Management and staff of Cheshire Homes Kabulonga



ACKNOWLEDGEMENTS

- I am thankful to God Almighty for His love and faithfulness. “I can do all things through Christ who strengthens me” (Philippians 4:13).
- To the Government of the Republic of Zambia, particularly the Ministry of Mines and Minerals Development and the Mine Safety Department, thanks a lot for permitting me to conduct this study.
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- I am greatly indebted to Mr. Ian Siluyele for his guidance and inputs on statistical analysis.
- I highly appreciate the assistance of the management and participants at Mopani Copper Mines.
- Great thanks to my beloved fiancé Mavis, my brothers; Gibson, Martin, Malama, Chanda, Emmanuel, Reagan and my sisters; Hazel and Gift for their encouragement, especially for their patience and endurance during my absence. My achievements are yours, also.
- Sincere gratitude to all my brothers and sisters in CHRIST, particularly Pastor Fatoba, Auntie Beatrice, Br. Masesa, Br. Lukonga, Br. D.B.S, Br. Mbulo and Mrs. Babajide for their prayers and moral support.

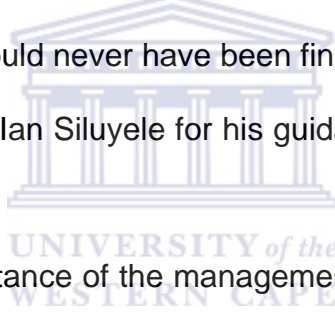



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ABBREVIATIONS

WMSIs: Work-related musculoskeletal injuries

MSD: Mine Safety Department

MSHA: Mine Safety and Health Administration

SOB: South Ore body

ZCTU: Zambia Congress of Trade Union

MMMD: Ministry of Mines and Minerals Development

MCM: Mopani Copper Mines

SADC: Southern African Development Community

UN: United Nations

U.S.A: United States of America

GDP: Gross Domestic Product

SPSS: Statistical Package for Social Sciences

ANOVA: Analysis of variance

SD: Standard deviation

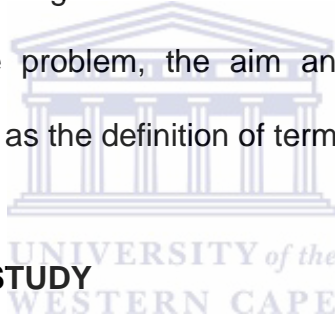


CHAPTER ONE

INTRODUCTION

1.1 INTRODUCTION

This chapter describes the background of the study by giving the general overview of mining and its economic impact. The chapter also reviews the predisposing factors, prevalence and consequence of work-related musculoskeletal injuries (WMSIs) among underground mine workers within and outside Zambia. An assessment of the state of the Zambian mining sector with regards to WMSIs is also included. The chapter also contains the statement of the problem, the aim and objectives of the study, the significance of the study as well as the definition of terms used in the present study.



1.2 BACKGROUND OF THE STUDY

The history of mining and trade in Southern Africa goes back nearly 1000 years with the scale of pre-colonial production being of considerable economic importance in some regions (Miller, Desai & Lee-Thorp, 2000). Minerals and mineral products are the backbone of most industries. In the absence of mined products like coal for fuel, iron, stone and sand for construction, and copper for wiring, virtually all modern transportation and manufacturing would cease (Joyce, 1998). The mining industry is a vital economic sector for many countries. In the United States (U.S.A) for example, mining contributes about 5% of the gross domestic product (GDP) and a much higher percentage in other countries (Groves, Kecojevic & Komljenovic, 2007). Considering

mining related jobs and miners' families, the mining industry supports an estimated 300 million people worldwide (Joyce, 1998).

Mining provides thousands of indigenous people with employment in many developing countries. It also accounts for a significant proportion of the GDP and quite often forms the bulk of foreign exchange earnings and foreign investment (Du Plessis & Du plessis, 2006; Löfgren, Robinson & Thurlow, 2002; Joyce, 1998). However, difficult market conditions, stiff competition, declining mineral grades, privatization and restructuring each put pressure on mining companies to embark on cost cutting programmes to stem losses (Craig, 2002). These changes not only affect retrenched mine workers who must find alternative employment but also those remaining in the industry who now are required to have more skills and flexibility, which calls in turn for more intensive work patterns (Joyce, 1998). Finding the balance between the need for minerals and the hazardous nature of mining is critical to improving the human health effects of the industry.

Mining has been characterized by most researchers as one of the most hazardous occupations amongst major industrial activities (Joyce, 1998; Kowalski-Trakofler & Barrett, 2003; Bio, Sadhra, Jackson & Burge, 2007). Mine workers must deal with a number of subtly harmful risks to safety and health, such as a high concentration of mechanical equipment in a confined space. Mine workers also face a constantly changing combination of workplace circumstances, both daily and through out the work shift. Some work is done in an environment without light or ventilation, and voids are created in the earth by removing material and burying the earth to ensure no immediate

reaction from the surrounding area occurs. As a result, mine workers are often exposed to a high risk of WMSIs (U.S. Bureau of Labor Statistics, 1991; Maiti, 2003). Occupational risk in underground mining is much higher than in surface mining (Karra, 2005; Komljenovic, Groves, & Kecojevic, 2007). Underground mine workers are required to perform labor intensive tasks that can often not be avoided due to limited work space (Bio et al., 2007). Underground mining involves drilling, charging and blasting to access and recover the ore (Joyce, 1998). Despite regulations, automation and increased attention towards reducing risks through safety campaigns, the mining industry is still associated with higher rates of injuries compared to other industries (Maiti, Chatterjee & Bangdiwala, 2004; Yi lee, Yu yeh, Wan Chen & Derwang, 2005; Komljenovic, Groves & Kecojevic, 2007).

Although mine workers represent approximately 1% of the global workforce, or about 30 million workers, mining is responsible for about 8% of total accidents at work (Joyce, 1998). Therefore, a better description and understanding of the effects of exposure profiles in the work place based on the results of epidemiological investigations is required (Punnet & Wegman 2004). There has been some degree of mechanization of mining activities in Southern Africa, however, manual work involving lifting of heavy loads still exists (Joyce, 1998). This author added that exposure to ergonomic risks in many developing countries is compounded by lax regulations which leave millions of mine workers at risk. In comparison with developed nations, incidence rates of occupational injuries in third world countries are said to be higher due to an inability to identify and analyze injury predisposing factors (Miller, Sinkala, Renger, Peacock, Tabor and Burgess, 2006).

Estimates of the burden of WMSIs suggest that reporting systems in Southern Africa probably underestimate the real burden of injuries by 50-fold (Loewenson, 2001). Miller et al. (2006) assert that despite the huge contribution of the mining industry to the economy of Sub-Saharan Africa, the rates of WMSIs are worrisome. These injuries cause substantial human suffering and consequently lead to reduced productivity (Lee, Yeh, Chen & Wang, 2005). Work-related morbidity not only results in suffering and hardships for the worker and his/her family, it also adds to the overall cost to society through reduced or lost productivity, and increased use of medical and welfare services (Hull, Leigh, Driscoll & Mandryk, 1996). Although the severe pain and suffering caused by these misfortunes cannot be quantified, the social and economic costs can be estimated (Hickman & Geller, 2003). Leigh, Macaskill, Kuosmas and Mandryk, (1999) reported that the cost of WMSIs to society has been estimated between 2 and 14% of the gross national product in various studies conducted in different countries.

Until recently, Zambia was among the leading producers of copper in the world (Garenne & Gakusi, 2006). In 1966, it ranked as the world's seventh largest producer of copper, generating 3.8% of the western world's production, and the world's second highest producer of cobalt (21.8%) behind the leading producer, the Democratic Republic of Congo which sources its copper ore from the strike-extension of Zambia's Copper belt mineralization (World Bank, 2000).

Since the establishment of Zambia as a nation, copper has been the single largest contributor to the Zambian economy (Craig, 2002). Copper has dominated the economy since large-scale mining operations started in 1924. At independence in 1964, copper

accounted for 91% of the total export earnings (Du plessis & Du plessis, 2006), approximately 64% of the country's foreign exchange earnings and 15% of formal employment in 2004 (Miller et al., 2006). This commodity still remains critically important for the Zambian economy (Löfgren, Robinson, & Thurlow, 2002).

An area of major concern in considering increased copper production and utilization is the health and safety of workers who mine or process the product. Hazards related to mining activities in the past have been especially serious, resulting in many mine-related disabling injuries. According to the Zambia Congress of Trade unions (ZCTU), most employers in Zambia do not pay attention to the health and safety of their employees as they consider this to be a cost ("Safety & Health in workplace", 2007). The trade union further stated that there have been complaints about hazardous working conditions in many new industries which have led to an increase in the number of workers who have suffered from WMSIs. To this effect, ZCTU called on the Zambian Government to strengthen the capacity of the inspectorate division of the Mine Safety Department (MSD) ("Safety & Health in workplace", 2007). The excesses in WMSIs associated with copper mining in Zambia, indicate the need for more comprehensive medical surveillance of copper mines. Given the rising number of occupational accidents in Zambia, there is an urgent need for the development and implementation of appropriate measures for preventing WMSIs amongst mine workers (Komljenovic, Groves & Kecojevic, 2007), particularly as the reliance upon copper increases.

While epidemiological studies have consistently implicated a common set of physical risk factors, especially in work place investigations, the magnitude of the association

varies substantially among studies (Punnett & Wegman, 2004). According to Maiti and Bhattacharjee (1999), the risk of occupational injuries can be associated with two major causes. The first concerns the characteristics of the work-environment and work-practices while the second cause, more controversial, involves the characteristics of the individual. However, it is not clear as to which occupational risk factors are most important. Therefore, an investigation of the interactive effects of various risk factors is relevant (Friedrich, Cermak & Heiller, 2000).

To date, no studies have reported the prevalence of and risk factors associated with WMSIs amongst mine workers in Zambia. The qualitative study by Miller et al. (2006) focused mainly on interviews with mine experts like engineers, whilst mine workers themselves were underrepresented. There were no injuries reported though antecedent factors like use of unsafe equipment and no maintenance of equipment were reported.

Paul and Maiti (2007) cautioned that mine safety management should outskirt their age old belief that mine injuries are due to the hazardous nature of mining and only engineering control and regulatory monitoring are sufficient for improving the safety of the mines. In a similar line of thought, Hine, Lewko and Blanko (1999) report that environmental considerations have broadened from the original narrow concern with the physical environment to a wider focus on work organization and the psychosocial environment.

The purpose of the current study was to determine the prevalence of and risk factors associated with WMSIs amongst underground mine workers in Zambia, using the

multifactorial causation model which according to Hine, Lewko and Blanko (1999) implies that injuries are caused by multiple rather than single factors.

1.3 PROBLEM STATEMENT

Limited published information is available on a national basis regarding the prevalence of and risk factors associated with work-related musculoskeletal injuries amongst mine workers in Zambia.

1.4 THE AIM OF THE STUDY

The aim of this study was to determine the prevalence of and risk factors contributing to WMSIs amongst underground mine workers at Mopani Copper Mines in Kitwe, Zambia.

1.5 SPECIFIC OBJECTIVES

1. To determine the prevalence of WMSIs amongst underground mine workers.
2. To identify the most affected body regions.
3. To identify common risk factors contributing to WMSIs.
4. To identify associations between affected body regions and variables like job activities.

1.6 SIGNIFICANCE OF THE STUDY

To date, no research has been conducted exploring the prevalence of and risk factors associated with WMSIs amongst mine workers in Zambia. Therefore, the results of this study may be used by health policy makers in developing effective injury prevention

programs in Zambia. The results will also increase worker awareness of risk factors associated with WMSIs. The new knowledge on prevalence and risk factors is also intended to challenge Zambian physiotherapists to go beyond treatment and instead promote preventative measures to reduce WMSIs amongst mine workers. Understanding the risk factors associated with WMSIs, is key to finding practical solutions for dealing with them (Wilson & Boyling, 2002).

1.7 DEFINITION OF TERMS

Occupational injuries: Defined as injuries that result from a work-related event (Ghosh, Bhattacharjee & Chau, 2004)

Occupational health: Workplace environment associated with presence or absence of certain conditions (Edelman & Mandle, 1998)

Musculoskeletal injuries: Defined as injuries of the musculoskeletal system (i.e. Muscles, joints, ligaments, tendons and includes nerves) (Dias & Shutte, 2005; Punnet & Wegman, 2004)

Musculoskeletal injury risk factors: Defined as factors that are associated with an increased likelihood of injury (Ostensvik et al., 2008)

Ergonomics: A science of reducing sources of biomechanical stress and resulting injuries by designing a better fit between the physical needs of employees and their workplaces (Radford, 2000; Furlow, 2002)

Underground Mine: The underground mine is a factory located in the bedrock inside the earth in which miners work to recover minerals hidden in the rock mass (Katz, 1995)

Mine worker: The term mineworker is the generic expression for wage-earners on the mines (Katz, 1995)

1.8 SUMMARY OF CHAPTERS

Chapter one provides an overview of the mining industry and its economic impact at national level, case in point Zambia, continental level, as well as the world. The possible causal or predisposing factors to WMSIs occurrence in Zambia are highlighted. The chapter also shows the prevalence and consequences of WMSIs among underground mine workers within and outside Zambia. The gaps in previous mine-related studies in Zambia are reported. The purpose of this study is described: determining the prevalence of and risk factors associated with WMSIs within the multifactorial causation framework.

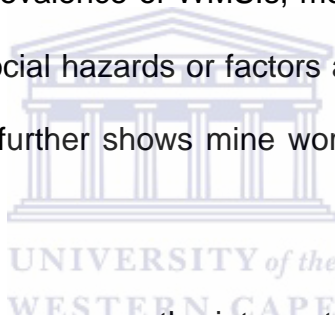
In chapter two, the literature reviews the main issues to be addressed in connection with the current study. These include WMSIs prevalence among mine workers, the anatomical sites or body parts prone to WMSIs, mechanisms and factors influencing occupational injury occurrence and injury prevention programmes.

In chapter three the research setting is described. It shows the geographical view of Zambia as well as the location of Mopani underground mines. In the research setting, the four mine shafts targeted in this study are also given. The chapter presents the design of this study, which is a cross-sectional retrospective study design. It thereafter

gives the details concerning the study population and sampling techniques. The need and procedures of pilot studies as well as problems encountered are highlighted. An in-depth description of data collection methods is concisely presented. This includes, tools used in data collection, data collection procedures and issues of reliability and validity of questionnaires for mine workers. The chapter ends by giving the data analysis and by showing how the issues of ethical considerations were addressed.

In chapter four, the demographic characteristics of the underground mine workers are reported. The presentation and brief description of the main findings in this study are displayed. These include the prevalence of WMSIs, most common body parts prone to injury, ergonomic and psychosocial hazards or factors associated with WMSIs reported by mine workers. The chapter further shows mine workers' suggestions of most likely preventative measures.

In chapter five, the discussion focuses on the interpretation of the main findings in this study. The identification and description of injury prevalence in this study is discussed, relative to the findings of the previous similar studies, where possible. Variables like age, experience and occupation of mine workers are discussed in consideration of their evidence in influencing injury occurrence as revealed in previous studies. The final discussion focuses on demonstrating the relationship between exposure to ergonomic and psychosocial hazards and sustaining an injury. The last chapter provides a summary, conclusions and suggested recommendations. These are based on the main findings of this study. The limitations of this study are also reported.

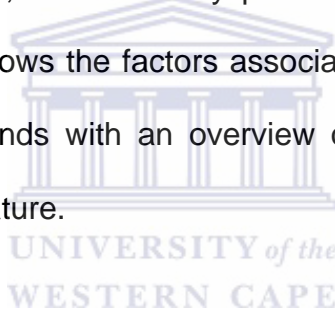


CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter presents a review of literature regarding studies on work-related musculoskeletal injuries (WMSIs) among mine workers. The literature is discussed under five headings. The first heading encapsulates the prevalence of WMSIs among mine workers. Secondly, the impact of WMSIs on both workers and employers is highlighted. In the third section, affected body parts and mechanisms of WMSIs are explored. The fourth section shows the factors associated with the occurrence of mine related injuries. The chapter ends with an overview of injury preventative measures presented in the published literature.



2.2 PREVALENCE OF WMSIs AMONGST MINE WORKERS

A number of studies concerning the prevalence of WMSIs amongst mine workers have been reviewed. Prevalence is a frequently used epidemiological measure of how commonly a disease or condition occurs in a population (Le & Boen, 1995). Prevalence measures how much of some disease or condition there is in a population at a particular point in time, such as the previous 12 months (Ural & Demirkol, 2007).

The prevalence of WMSIs has increased dramatically in developed and developing nations (Rosecrance & Cook, 1998). Injury rates in surface mines are however relatively low when compared with underground mines. Studies in the United States of America

(U.S.A) found that the mean injury rate on the surface was 52.53% lower compared to the rate underground (Karra, 2005; Komljenovic, Groves, & Kecojevic, 2007). Although safer modern underground mining methods have been introduced in most mines, the mining industry still remains one of the most dangerous industries (Sari, Duzgun, Karpuz & Selcuk, 2004) and has the highest injury frequency rate of all industries (Hull, Leigh, Driscoll & Mandryk, 1996).

A detailed analysis of musculoskeletal injuries among the underground mining workforce, for the years 1983 to 1984 in the U.S.A, showed an overall average of more than 2600 injuries per year (Winn, Biersner & Morrissey, 1996). Subsequently, the Mine Safety and Health Administration (MSHA) reports that the injury rate decreased from 6.30 to 4.05 per 100, 000 workers over the period 1995 to 2004 and from 6.30 to 3.92 per 100 full time workers for the period 1995-2005 (Groves, Kecojevic & Komljenovic, 2007; Komljenovic, Groves & Kecojevic, 2008). Although a continuous decrease in the number of injuries is apparent, these authors reported that the injury rate per 100 000 workers in mining was still more than four times higher than the average rate for all industries in 2004 (Grove et al., 2007). The data for coal mines in the U.S.A indicates a total of 311,965 injuries for the 28-year period from 1978 through to 2005 (11, 141 per year) (Coleman & Kerkering, 2007).

According to the Health and Safety Statistics in the United Kingdom (2002), mining is the riskiest industry in terms of injuries to workers. For the period 2001 and 2002, the prevalence of WMSIs in the mining, water and railway industries were reported at 803.9, 652.1 and 631.1 per 100 000 workers respectively. In Australia, Larsson and Field

(2002) found that mine workers run an eight times higher risk than the average employee of sustaining a severe injury at work. The injury prevalence rate (number of injuries per 100 workers) for the underground coal mining industry in 1986/87 (26.6) was over six times the average for all industries in New South Wales (4.3) (Hull et al., 1996). Hull et al. (1996) further reported an injury prevalence rate of 62% resulting in one or more days lost from work for the year 1990 to 91. In Italy and France, musculoskeletal injuries due to biomechanical overload have increased from 873 to 2000 between the years 1996 and 1999, and 2602 in 1992 to 5856 in the year 1996 (Buckle & Devereux, 2002).

In India, the injuries in the mines are quite high and remain stagnant over the last 20 years. The underground coal mine injury rates per 1000 persons for the years 1999 and 2000 were 1.21 and 0.90 respectively (Maiti, Chatterjee & Bangdiwala, 2004). The Directorate General of Mines Safety statistics in India shows WMSI rates of 0.28 per 1000 persons employed for the year 2001 and 1.21 per 1000 persons employed for the year 2002 (Paul, Maiti, Dasgupta & Forjuoh, 2005).

A study by Loewenson (2001) reported injury rates higher than 30 per 1000 miners in African countries. A survey undertaken to determine the prevalence and predisposing factors for low back pain among male underground gold miners at Obuasi gold mines in Ghana, found a twelve month prevalence of 67% amongst gold underground miners (Bio, Sadhra, Jackson & Burge, 2007). In the Southern African Development Community (SADC) region, 0 – 49 injuries occur with a median of 6 injuries per 1000 workers and reported data further indicates an annual injury rate of 1 per 1000 workers

in Zambia for the year 1995 (Loewenson, n.d.). However, there is no specific literature on prevalence of WMSIs amongst mine workers in Zambia.

According to Ural and Demirkol, (2007) the mineral extracting industries of Turkey have the highest incident rates and highest injuries among the major mine-producing countries. A study conducted to determine the effects of mining methods on productivity and safety between two Turkish underground mines of two different panels (conventional and mechanized) reported a slight increase in injury incidence rates from 0.36 to 0.39 injuries per man per year in mines with conventional mining between 1994 to 1997 and 1997 to 2002, respectively (Sari, Duzgun, Karpuz & Selcuk, 2004). A comparative study conducted by Ural and Demirkol, (2007) between Turkish mineral-extracting industries and major mine-producing countries revealed that the incidence rates per 100,000 workers of injuries of Australia, Germany, Great Britain, New Zealand and U.S.A are significantly lower than those of Turkey and South Africa. In the U.S.A, a systematic risk analysis undertaken to thoroughly characterize injuries for the 10 year period from 1995 to 2005, reported a decrease in the overall injury rates from 6.30 to 3.92 per 100 full time workers for the period 1995 to 2005 (Komljenovic, Groves and Kecojevic, 2007).

Literature has shown that different studies have been carried out world wide concerning the prevalence of WMSIs. However, cross-country data for work-place injuries has limited reliability and comparability (Mainardi, 2005). Comparison between countries is difficult because of differences in reporting practices as well as differences in the definition of terms used (Ural & Demirkol, 2007). Estimating the prevalence of WMSIs

has also proven to be difficult due to lack of standardized measures (Buckle & Devereux, 2002). It is also evident that few studies have been conducted in developing countries, particularly in Africa.

2.3 SOCIAL AND ECONOMIC IMPACT OF WMSIs

Health problems associated with WMSIs impact on an individual's life in a number of ways. It may affect more than employers' costs and individuals' income; the health problems associated with WMSIs may also have broader and longer lasting consequences with regard to families' wealth and welfare (Galizzi & Zagorsky, 2008). Understanding workers' post-injury experience is vital to a full appreciation of their losses. Injured workers incur costs caused by utilization of pharmaceuticals, physician visits, physical therapy and orthopedic aids, as well as spells of rehabilitation treatment (Linton & Ryberg, 2000; Wenig, Schmidt, Kohlmann, & Schweikert, 2008). Workers also experience a wide range of limitations on family and social roles, including physical impact that hampers workers' ability to do household chores and to engage in leisure activities with their spouses (Strunin & Boden, 2004). In addition, these impacts lead to depression, anxiety and anger among the injured workers (Watson, Booker, Moores & Main, 2004; Strunin & Boden, 2004). Injuries also lead to production losses caused by temporary inability to work, and premature retirement (Wenig et al., 2008). Estimates of the economic costs associated with lost work days following injuries occurring in a single year exceed \$95 billion (Mackenzie, et al., 1998). Lost work day measures offer an alternative metric for evaluating job safety and health performance (Coleman & Kerkerling, 2007). Lost work day injuries force a worker to spend time away from work

(Miller, 1995). Underground mine workers appear to be at higher risk of lost work day injuries than other mine workers. It is estimated that 30-40% of lost work-days result from injuries among underground mine workers (Winn, Biersner & Morrissey, 1996). According to the summary statistics of all injuries reported to MSHA from 1983 through to 2004, there were 31,515,368 lost work days associated with mining industries in the U.S.A (Coleman & Kerkerling, 2007). An increase in the contribution of injuries occurring underground to the total working days lost and compensation paid, has also been reported (Hull et al., 1996). Musculoskeletal injuries in Australian coal mining represent 67% of compensation claims involving five or more lost days (Burgess-Limerick, Straker, Pollock, Dennis, Leveritt & Johnson, 2007). Worker eligibility to compensation varies, in most cases a minimum of two to nine days of lost work are required to qualify (Miller, 1995). Hull et al. (1996) added that the average compensation payment for injuries in the mining industry in 1990-91 was one and a half times the average compensation payment for all industries in New South Wales.

Literature clearly shows that underground mine workers and employers alike suffer substantially a great deal of losses in terms of increased compensation payments incurred by mine companies as well as the decrease in production resulting from lost work days. Literature also shows the consequent economic and social hardships experienced by workers and their families following injury. Therefore, identifying hazards to occupational injuries is crucial to developing appropriate preventative measures.

2.4 BODY PARTS AND INJURY MECHANISMS

2.4.1 Commonly injured body parts

Most studies reviewed under prevalence also took into consideration body parts injured, injury mechanisms and nature. The most commonly injured body parts included the lower back, neck, shoulder, forearm, wrist/hand (Punnet & Wegman, 2004), knees and ankles/feet (Buckle & Devereux, 2002). The prevalence of back injuries among mine workers ranged from 37-82% of the total injuries incurred (Dias & Shutte, 2005; Bio et al., 2007; Moore, Bael & Steiner, 2007). In the studies conducted by Sari et al. (2004), Wiehagen and Turin (2004), Dias and Shutte (2005), Moore, Bael and Steiner (2007), the back was the most commonly affected body region, followed by the knee joint. However, according to O'Reilly, Miur and Doherty (2000), the knee joint was the most commonly affected joint amongst mine workers when compared with other industrial occupations due to frequent knee bending and possibly heavy lifting. In contrast to these findings, Buckle and Devereux (2002) found that the most commonly affected body region was the neck (28%), followed by the elbows (7.5%). The difference was due to the focus on only musculoskeletal injuries of the neck and upper limbs in this study.

2.4.2 Mechanisms of injury

Although mining has become increasingly mechanized, there still remains a substantial amount of manual handling. As a result, cumulative trauma injuries continue to constitute the largest category of occupational injuries in mining (Donaghue, 2004). Material handling accounts for 54-71% of all injuries sustained by mine workers (Sari et

al., 2004; Groves, Kecojevic & Komljenovic, 2007). Studies conducted by Sari, et al. (2004) and Groves, et al. (2007) found that material handling was the most common injury mechanism. Injuries also result from overexertion, striking against or stepping on objects and slip or fall of a person (Hull, Leigh, Driscoll & Mandryk, 1996; Groves, et al., 2007). In a study conducted by Groves, et al. (2007) the second most common mechanism of injury after material handling was slip or fall of a person (16%) followed by machinery and hand tools (12 and 11% respectively). These authors also added that inadequate training and poor haulage roads are the most contributing factors.

Occupational activities typical of accidents caused by projected flying or falling objects are normal production tasks, and also maintenance and repair. The majority of upper limb injuries are associated with the manipulation of hand-held machines or tools (Laflamme, Menckel & Lundholm, 1996). Falls and missteps lead to injuries of the back or lower limbs. Literature shows that injuries could also result from dust or gases, fires, interaction with machinery, confined working spaces, repetitive work, vibration (Karra, 2005) as well as hazards like poor illumination and ventilation (Mitchell, Driscoll & Harrison, 1998).

Manual installation of overhead pipes, cables, conveyor and roof support systems in underground mines are among other causes of injuries in the mines. However, many of these jobs are partially or fully mechanized and much more time is spent operating machines and driving vehicles (McPhee, 2004) which, according to Donaghue, (2004) also predispose mine workers to injury as a result of mobile equipment accidents, overexertion and entrapments.

Given the controversy in literature with regards to the body regions at risk and mechanisms of injury, data collection of WMSIs in a country like Zambia is key, as identification of the body regions at risk is essential in assisting with identifying aspects of the tasks to which control measures should be targeted (Burgess-Limerick, 2007).

2.5 FACTORS INFLUENCING WORK - RELATED MUSCULOSKLETAL INJURIES

Although substantial progress has been made in the control of occupational health hazards, there remains room for further risk reduction with particular regard to traumatic and ergonomic hazards (Donaghue, 2004). According to Franco and Fusetti (2004), there is need for studying the working process and identifying ergonomic hazards in order to reduce risk amongst the working population. Understanding the underlying causes of injuries provides knowledge that guides the behavior of workers to prevent recurrences. When accurately identified, these causal analyses have provided the bedrock for successful safety interventions and accident prevention measures (Gyeke, 2003).

It is becoming widely accepted that technical approaches alone are inadequate to reduce accident rates to desired levels. This has led many organizational researchers and theorists to explore alternative perspectives that take into account the broader social context in which accidents occur (Hine, Lewko & Blanco, 1999). It is likely many WMSIs reported in the mining industry have a multi-factorial etiology with psychosocial and individual factors contributing significantly (Rosecrance & Cook, 1998). Investigations that have been carried out on this subject, reveal that both the individual

and workplace characteristics of mine workers have significant effect on the risk of occurrence of injuries (Maiti & Bhattacharjee, 1999; Sari et al., 2004; Paul & Maiti, 2007). The workplace characteristics or work environment refer to equipment, task characteristics and the organizational structure (Moller & Rothmann, 2006). Organizational structure encompasses the way in which work is structured and supervised (Barret, Haslam, Lee & Ellis, 2005). A study conducted by Buckle and Devereux, (2002) revealed that individual worker characteristics such as age and experience have an effect on the way work is performed. However, Groves et al. (2007) argues that it is difficult to separate the effects of age and experience on injury, since older workers typically have more experience.

2.5.1 Personal potential risk factors

2.5.1.1 Age

Generational categories like age groups are one method of exploring mining injury data. While there are different ways that people categorize age, they are all fairly similar (Mallet, Peters & Schwerha, 2006).

Many studies have been conducted to observe the effect of age on injury rate. Maiti and Bhattacharjee (1999) found that more injuries occurred at the 30-40 year age group which accounted for 33.30% of the total injuries. Similar findings were reported by Sari et al. (2004) indicating that amongst miners (30-40 years old), experiencing an injury was more probable than in older age groups. Paul and Maiti (2007) found a highly significant, direct positive relationship between mine workers aged 37 years old and injury. It was concluded that workers (30-40 years) are more prone to be involved in

injuries. Laflamme, Menckle and Lundholm (1996) and Ural and Demirkol (2007) reported that mine workers younger than 45 years, were more prone to injury though injuries tended to be more severe in older worker groups. Hull, Leigh, Driscoll and Mandryk, (1996) also found a relationship between age and injury severity. The study concluded that the older the worker, the more severe his injury. A significant greater risk was also seen for the 24-39 years category (Groves et al., 2007). These findings were consistent with the assumption that older workers are more likely to be more experienced and hence show a significantly lower risk of injury. Bio, Sadhra, Jackson and Burge (2007) and Ghosh, Battacherjee and Chau (2004) found a significant relationship between increasing age and injury. These authors found that mine workers aged between 35 and 45 years were more susceptible to injury than their counterparts in age group 30 years and younger.



2.5.1.2 Occupation and experience

The effect of job experience and type of occupation on injury rate has been widely investigated. Experience represents the amount of time an employee engaged in his work. This may be his total mining experience or the job experience (Paul & Maiti, 2007).

In a study by Maiti and Bhattacharjee (1999), it was found that the most experienced miners (10-20 and >20 years) have a higher probability of being injured. Regarding occupation, the authors found that the face workers were experiencing more injuries than the haulage workers and others. In another study, the variable experience was however not statistically related to injury amongst underground mine workers (Paul &

Maiti, 2007). Bio, Sadhra, Jackson and Burge (2007) found high back injury prevalence among workers performing engineering (82%) duties. In their study, Groves et al. (2007) observed that more than 50% of the employees injured, had less or equal to five (5) years experience in their current job and regarding occupation, conveyors had the highest percentage of employees with injuries. Hull et al. (1996) found no significant association between occupation and work experience. However, the authors revealed that in terms of occupation, injuries experienced by mechanical unit men were significantly more severe than injuries experienced by other trade persons, though by 17% only. Workers who work mostly at production related operations like supporters and 'workers' were generally injured more frequently than employees under other job titles (Sari, Duzgun, Karpuz & Selcuk, 2004). In an analysis of the occupational incidence and severity in Victoria, between 1992 and 1998, Larsson and Field (2002) identified miners and drillers, among others, as priorities of interventions and prevention.

There seem to be a general consensus in literature regarding the relationship between increasing age (30-45) and work-related musculoskeletal injuries. However, experience and occupation bear no definite relationship with injury as conflicting results are indicated in the literature.

2.5.2 Direct physical risk factors (Ergonomic risk factors)

The physical ergonomic aspects of the work environment often cited by both epidemiological studies and experimental science as risk factors for WMSIs in the mines, include highly repetitive motions, forceful exertions, vibration exposures,

poor/awkward posture, forceful gripping and jolting/jarring (Wilder, Pope & Magnusson, 1996; Wiehagen & Turin, 2004; Punnett & Wegman, 2004; Kara, 2005).

As far back as 1633-1714, Bernardino Ramazzini observed that a variety of common injuries could originate following irregular motions and prolonged postures of the workers body, the responsibility of biomechanical overload and awkward postures is recognized as the cause of injuries amongst miners (Franco & Fusetti, 2004), usually due to long term stress in human soft tissues such as nerves, tendons and the joints (Mirmohamadi, Seraji, Shahtaheri, Lahmi & Ghasemkhani, 2004). These risk factors have also been identified in other studies conducted in the U.S.A (Winn, Biersner & Morrissey, 1996; Torma-Krajewski, Hipes, Steiner, & Burgess-Limerick, 2007; Burgess-Limerick, Straker, Pollock, Dennis, Leveritt & Johnson, 2007), Australia (McPhee, 2004), the Netherlands (Ariens, van Mechelen, Bongers, Bouter & van der Wal, 2000) and South Africa (Dias & Schutte, 2005). Ergonomic risk factors have been associated with the increased prevalence of WMSIs (Rosecrance & Cook, 1998). Some of these factors include time aspects of work. Predictable risk factors may include percentage of time with hands above the shoulders, working with hands above the shoulders, and working with trunk or neck flexion (Wells, Mathiassen, Medbo, & Winkel, 2007).

Dembe, Erickson, Delbos and Banks (2005) analyzed the impact of overtime and extended working hours on the risk of occupational injuries and found that working in jobs with overtime schedules was associated with 61% higher injury hazard rate compared to jobs without overtime.

Many underground mines have confined operator platforms (Kowalsky-Trakofler & Barret, 2003), hence requiring miners to maintain awkward postures throughout their work shifts and thereby creating stress to their muscles and joints (U.S. General Accounting Office, 2003). Most prolonged awkward body postures are as a result of restrictive ceiling heights and angles of the work place (Dias & Schutte, 2005). McMillan and Nichols (2005) reported that a combination of lifting, kneeling and squatting, an activity performed by miners in the course of their work, is associated with a more excessive risk of injury than that attributed to kneeling and squatting alone.

Repetition contributes the highest number of exposure reports amongst miners, followed by heavy lifting while constant use of vibration tools has the least number of reports (Torma-Krajewski et al., 2007). In South Africa, the prevalence rate of hand-arm vibration syndrome is estimated at 15% of mine workers exposed to vibration in gold mines, while in the U.S.A, it has been reported to be as high as 50% (Mandal & Srivastava, 2006).

These authors implicate physical conditions other than vectors in causation. Contributors to this body of literature introduce psychosocial concepts like stress and imply that injuries are caused by multiple rather than single factors (Hine, Lewko & Blanco, 1999).

2.5.3 Psychosocial Factors

Behavioral safety analysis has been identified as an effective alternative in many industries including mining (Paul & Maiti, 2007). There are now plausible models and

scientific evidence indicating that organization and psychosocial work factors are associated with the development of WMSIs (Buckle & Devereux, 2002). Work-related psychosocial factors include; work load, job control and social support (Dias & Schutte, 2005).

A survey by Paul, Maiti, Dasgupta and Forjough (2005) reports that physical environment coupled with personality traits and the psychological state of an individual may lead to inappropriate actions that may eventually predispose them to injury at work. In their assessment of the relationship of human behavioral factors to occupational injuries, Ghosh, Bhattacharjee and Chau (2004) found that workers with emotional instability have a higher risk of occupational injuries. Macfarlane, Hunt and Silman (2000) identified dissatisfaction with support from colleagues or supervisors as the strongest work related psychosocial risk factor. They further contended that psychological distress and aspects of illness behaviors are important predictors of the onset of musculoskeletal pain in addition to work-related psychosocial and mechanical factors.

A case study conducted by Paul and Maiti (2007) showed that an injured group of workers are more job dissatisfied and negatively affected compared to an uninjured group of workers. The study concluded that negative affectivity, job dissatisfaction and risk taking behaviors predict an increased number of injuries in mines. Other factors under psychosocial risk factors to be considered include; personality, social support and job involvement and relationship between co-worker and supervisor support (Maiti, Bhattacharjee & Bangdiwala, 2004). Bongers, Winter, Kompier and Hildebrandt (1993) concluded that monotonous work, high perceived work load, and time pressure are

related to musculoskeletal symptoms. They further observed that low control on the job and lack of social support by colleagues are positively associated with musculoskeletal injuries.

It is evident in the attribution literature that without the identification of risk factors associated with WMSIs in underground mines, efforts to prevent injuries will continue to prove futile.

2.6 MINE SAFETY INTERVENTION STRATEGIES

To reduce the prevalence of WMSIs amongst mine workers, researchers have proposed health and safety programmes that emphasize primary prevention strategies through causal explorations (Rosecrane & Cook, 1998; Gyeke, 2003). To achieve this, knowledge is required about where hazardous exposures create problems and in which ways workers are exposed to injury risks (Larsson & Field, 2002; Torma-Krajewski et al., 2007; Komljenovic, Groves & Kecojevic, 2008). If hazards are not recognized, response by the worker becomes reactive rather than proactive and may lead to serious injury (Kowalski-Trakofler & Barret 2003). In a study by Torma-Krajewski et al. (2007), prior recognition of hazards encountered in each mining activity led to a decline of musculoskeletal complaints by 17% following implementation of the ergonomic process at a U.S.A coal mine. A study conducted by Miller et al. (2006) reported that inability to identify hazards in Zambia has led to failure of interventions to yield appreciable long-term improvement in the mining sector.

Literature shows that the development of a proper safety management system requires continual attention to three domains namely, the environment, the person and behavior (Hine, Lewko & Blanco, 1999; Barret, Haslam, Lee & Ellis, 2004; Maiti, Chatterjee & Bangdiwala, 2004). To this effect, Groves, Kecojevic and Komljenovic (2007) proposed a two-pronged approach to injury prevention, one that is fundamental and traditional (i.e., engineering enforcement and education) and one that is more innovative and creative such as applying behavioral principles and technological advances to better control and eliminate hazards. Maiti, Chatterjee and Bangdiwala (2004) emphasized that only engineering solutions to injury prevention are inappropriate unless coupled with focused attention to the attitudes and behaviors of the mine workers. Data available in literature also suggests that active involvement of the individual worker is essential in ensuring continued improvement of mine workers safety and health (Buckle & Devereux, 2002). In addition, the human-centered approach to intervention is fundamental to the ethics of ergonomics that strives to improve integration between people, equipment and environment (Barret, Haslam, Lee & Ellis, 2004). However, a study by Paul and Maiti (2007) proposed an approach that focuses on both micro and macro organizational factors affecting safety, that stem through improved process and procedure, management and policies, supervision and management-workers relationships.

In order to ensure significant reductions in injuries, decreased health care costs and improvements in production efficiency (Rosecrance & Cook, 1998), prevention of WMSIs amongst underground mine workers is of vital importance.

CHAPTER THREE

METHODOLOGY

3.1 INTRODUCTION

This chapter describes the research setting, the study design and the rationale for the selected research setting as well as the implementation of the sampling techniques used. The methods of data collection and analysis as well as the description of the pilot study are also given. This chapter ends with ethical considerations during the course of data collection.

3.2 RESEARCH SETTING

The study was conducted on the Copper Belt Province of Zambia. The Republic of Zambia is a landlocked Southern African country covering an area of about 753 000 square kilometers (UN, 2005). It shares borders with the Democratic Republic of Congo and Tanzania in the north, Malawi and Mozambique in the east, Zimbabwe and Botswana in the south, Angola and Namibia in the west and south west respectively.

The Copper Belt Province of Zambia is one of the nine provinces of Zambia. It is the copper mining province of the country and has ten districts most of which have at least one mine each. The districts with mines include Ndola, Kitwe, Chingola, Mufulira, Luanshya and Chililabombwe. Kitwe district was selected for this study. It has underground mines; Mopani in the south-west and Mindolo in the north-west. Kitwe is the third largest district in Zambia with a population of 363, 734 (UN, 2005). Mopani underground mine was selected for the current study, the selection of the mine was

based on its size as it also includes a concentrator, smelter and refinery as well as four copper and cobalt plants namely Central shaft, Mindola shaft, North shaft, and South Ore body commonly known as SOB. Secondly, the mine's leading number of reportable accidents in Zambia also attracted the researchers attention.

3.3 STUDY DESIGN

The study design used in this project was a cross-sectional retrospective quantitative design. The data was retrospectively collected over a period of one year (2007). This type of research is conducted to estimate the prevalence of the outcome of interest for a given population, including exposure to risk factors. In this way cross-sectional studies provide a 'snapshot' of the outcome and the characteristics associated with it, at a specific point in time (Levin, 2006). In this type of survey, a carefully selected probability sample in combination with a standardized questionnaire offers the possibility of making refined descriptive assertions about a population (Babbie & Mouton, 2006).

3.4 STUDY POPULATION

The study was conducted on underground mine workers from all the four underground shafts at Mopani mines in Kitwe. Only underground mine workers were targeted in this study in accordance with the objectives. The central shaft had 520 workers, Mindola 590, North and SOB 201 and 585 respectively, bringing the total number to 1 896.

3.5 SAMPLING TECHNIQUE

Stratified random sampling technique according to job types was used to realize the sample of this study. According to Babbie and Mouton (2006), a stratified random sampling technique ensures proportional representation of the population. Each job type made a stratum as one of the objectives of the study was to make associations between work-related musculoskeletal injuries and job types. De Vos (2002) succinctly states that stratification consists of the universe being divided into a number of strata that are mutually exclusive, and the members of which are homogeneous with regard to some characteristic.

In this light, 40 strata were initially formed based on the existing job types at Mopani underground mine namely; artisan fitter, artisan rigger, artisan boiler maker, blasting license holder, bob cat driver, cage tender, callout clerk, clinical officer underground, crusher operator, diesel loader driver, draughtsman, electrician, engineer, geologists, grade control officer, locomotive driver, maintenance officer, mechanic, metal fabricator, mine captain, miner, mobile equipment inspector, pump chamber operator, pump man, rock breaker driver, safety coordinator, section boss, shift boss, skip man, spanner man, stopper, surge bin operator, surveyor, timber man, truck layer, underground plant fitter, ventilation officer, whistle man, winding engine driver and work men. However, due to relatively small numbers of employees in some strata, final strata were formed by combining similar job types like metal fabricators, underground plant fitters, artisan fitters and mechanics in one stratum (mechanic). This exercise enabled the researcher to come up with seven strata comprising major job types, which were fewer and manageable. The final seven strata from which the sample was drawn were mechanics,

electricians, diesel loader drivers, miners, supervisory, locomotive drivers and others. The 'others' category constituted 'minor' occupations with few workers like callout clerks, bob cat drivers, draughtsman, pump chamber operators and surge bin operators

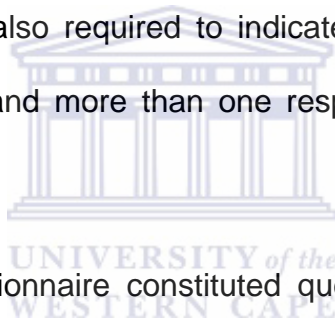
The sample was then drawn proportionally within each of the different strata using random number tables. This implies that each sample was randomly selected according to the number of participants in that stratum. An estimated sample size of 500 mine workers was computed where the margin of error is 0.05 using the approach outlined by Bartlett, Kotrlik and Higgins (2001). For this sampling technique, a list of mine workers per shaft was given to the researcher by the human resource manager. If a selected mine worker decided not to participate in the study or was reported absent, we passed on to the next candidate until we had the required number of participants in each stratum. This enabled the researcher to get a sample of 500 mine workers. This technique ensured an optimal chance of drawing a sample that is representative of the population from which it was drawn (De Vos, 2002).

3.6 STUDY INSTRUMENTS

3.6.1 Self administered questionnaire

The self administered questionnaire (Appendix H) used in this study was developed from existing surveys of occupational injury and risk factors. Various questionnaires were used to compile the questionnaire for this study namely; the Standardized Nordic questionnaire (Kuorinka, Jonsson & Kilbom, 1987), Modified version of the Washington state risk factor checklist (Torma-Krajewski, 2007a) and the upper limb Core QX

checklist (Torma-Krajewski, 2007b). These questionnaires were used in guiding the design. The questionnaire (Appendix H) was divided into four sections, in the first section; mine workers were required to provide demographic and other general information like occupation title and mine section. The second part of the questionnaire consisted of an injury profile. The subjective pain/discomfort on different body regions were measured using a modified version of Nordic Questionnaire by Kuorinka, Jonsson and Kilbom (1987). This section recorded data on whether the worker has had injury on duty or experienced bodily discomforts during the preceding 12 months. A “yes” response was used to ascertain the prevalence of work-related musculoskeletal injuries (WMSIs). Mine workers were also required to indicate the anatomical location (body parts) of the injury sustained and more than one response was permitted. Pain was measured at past 12 months.



The third section of the questionnaire constituted questions on physical risk factors which were measured using a modified version of the Washington state risk factor checklist (Torma-Krajewski, 2007a). This section measured the characteristics of the work-environment and work-practices like machines used, postures adopted at work and total work duration per day. In order to provide estimates of safety hazards with regard to ergonomic hazards to which underground mine workers are exposed, miners were required to report health hazards for their job types. Miners were asked to check the length of exposure to an activity which was used to determine whether the condition was caution (lower level of risk) or hazard (higher level of risk).

The fourth part recorded psychological and psychosocial risk factors which were measured using a modified version of the upper limb Core QX checklist (Torma-Krajewski, 2007b). The participants in this section responded to questions that employed a four point response format (1=strongly disagree; 2=disagree; 3=agree; 4=strongly agree), which allowed them to rate their own attributions on dimensions of psychosocial causality factors.

3.6.2 Translation

The original questionnaire (Appendix H) was designed in English and was later translated by a professional translator into the local (Bemba) language so as to maximize the reliability of the responses by the respondents. However, the participants preferred the English version of the questionnaire to the Bemba one because they were conversant with the English language as the minimum qualification for consideration for employment at Mopani mine is a grade twelve certificate.

3.7 PILOT STUDY

According to De Vos (2002), the purpose of the pilot study is to improve the success and effectiveness of the investigation. The author adds that the suitability of the questionnaire should be considered the most valuable function of the pilot study as there is always the certainty of possible error and pre-testing the instrument is the surest protection against such errors. Prior to obtaining an overview of the actual, practical situation where the investigation was conducted, content validation of the

questionnaire was done by senior lecturers at the Mines and Physiotherapy departments of the University of Zambia.

To ensure that the instrument appeared to measure the attributes under consideration (face validity), the questionnaire (Appendix H) was pilot-tested on five mine workers at Mopani underground mine. The pilot study was also undertaken to assess whether the participants easily understood questions asked and also how long it would take to complete the questionnaire. This provided feedback regarding the clarity of the questions and the overall presentation of the questionnaire. In order to avoid biased responses, the subjects of the pilot study were automatically excluded from the main study.

The initial method of instrument administration was through interviews. However, a week before the pilot study the mine management decided self administered method be used instead. The reasons for the change of questionnaire administration methods were two fold. The first reason according to the mine management was that mine workers would have treated the time spent with them during the interview as work-related and hence demand allowances. Another one was by virtue of the nature of their job which in most cases requires them to work in shifts. The latter reason would have made it difficult for the researcher to access participants. The change of questionnaire administration methods warranted the addition of instructions in every section of the instrument so as to enhance the understanding of participants. The questionnaires were then distributed by the researcher and two research assistants. Participants were allowed to complete the questionnaires at their own convenient time due to the nature of

their job as the majority of them work in shifts. The instruments were completed in two days and collected from the participants by the researcher and research assistants.

After the pilot study, the researcher held a meeting with the assistants to discuss the difficulties encountered by the participants. The only problem encountered during the pilot study was the way questions were asked in question one (1) of section B. A mismatch between body parts injured was noticed in question one (1) b, c and d. The necessary changes were made to rectify the typographic error and the assistants were made aware of the changes made to the instrument (Appendix H) after the pretest.

3.7.1 Reliability and validity

Reliability is a matter of whether a particular technique, applied repeatedly to the same object, would yield the same result each time (Babbie & Mouton, 2006). While the term validity refers to the extent to which an empirical measure adequately reflects the real meaning of the concept under consideration. De Vos (2002) adds that validity ensures that the instrument measures the concept in question and the concept is measured accurately. According to Kottner and Dassen (2008) reliability is a pre-requisite for any kind of validity.

The musculoskeletal injury questionnaire used in the present study was developed from three existing surveys of occupational injury and risk factors namely the Standardized Nordic Questionnaire (Kuorinka, Jonsson & Kilbom, 1987), the modified version of the Washington state risk factor checklist (Torma-Krajewski, 2007a) and the upper limb core Qx checklist (Torma-Krajewski, 2007b). The reliability and validity of the

Standardized Nordic questionnaire for the analysis of musculoskeletal symptoms has been shown to be acceptable (Kuorinka, et. al., 1987). Palmer, Smith, Kellingray and Cooper, (1999) found the instrument highly repeatable and sensitive by calculating a Kappa coefficient (k) (k=0.63-0.90), while the reliability and validity of the other two instruments have not been reported in the published literature. The internal consistency of the overall instrument (Appendix H) used in this study was assessed with the cronbach's alpha. The reliability analysis indicated a high estimate of internal consistency (cronbach's alpha=0.53-0.9). According to conventional rules, any coefficient exceeding 0.70 is regarded as high (Patel, Ekman, Spertus, Wasserman & Persson, 2008). Regarding face validity, the participants found the questions short, easily understandable and the whole form required approximately 20 minutes to complete. The team of lecturers (experts) at the University of Zambia found the content of the questionnaire valid and representative of work-related problems faced by mine workers.

3.8 PROCEDURE

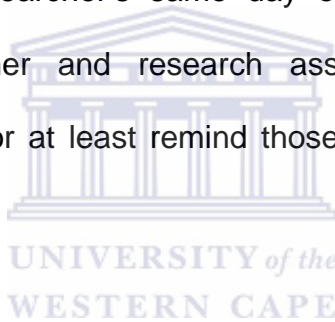
On approval of the research study by the University of the Western Cape Senate, Higher Degrees Committee as well as the ethical permission to conduct the study from the Senate Research and Study Grant Ethics Committee (Appendix A), the researcher requested permission to conduct the study from the Mopani Copper Mines (MCM) management (Appendix B) as well as the Ministry of Mines and Minerals Development (MMMD) in Zambia (Appendix D). Written feedback was obtained from both the MCM management and the MMMD (Appendices C and E, respectively). In addition, written consent was sought from all participants (Appendix G).

The data collection of the present study needed involvement of research assistants due to the nature of the study and limited time frame allocated to the study. To this effect, one radiographer and a school leaver were trained as research assistants for this study. The researcher did the training over three days. The purpose of the training was to promote a good understanding of the study in general, the aim of the study, clarify their role as research assistants as well as their understanding of questions addressed to the participants. The ethics of the study was also explained to the research assistants. Their role was to distribute and collect the questionnaires and also assist mine workers with difficulties encountered during the completion of questionnaires.

To ensure accuracy of responses, participants were assured that all responses were completely confidential and that no person affiliated with their mine was involved in the study in any way. This was achieved through distribution of consent forms (Appendix G) to all stake holders. A brief explanation of what the research was all about was given to the section bosses and mine captains. The participants were then informed (Appendix F) about the research and the importance of their participation. All the instructions were provided before any data collection to allow clarification. On the first day, the researcher introduced the research assistants to the participants before any consent forms could be distributed. The researcher and research assistants then made an appointment with the mine section supervisors and all the participants who were available about the day and time of questionnaire distribution. The questionnaire (Appendix H) was in English as the researcher was assured by management that the minimum qualification for employment considered at the mine is a full grade twelve (12) certificate which implied that the participants could understand the English language. The questionnaires were

distributed by the researcher or research assistants and by the person (section supervisors) delegated by the mine authority. The researcher worked closely with the mine section supervisors who also helped to distribute questionnaires to mine workers reported to be in night shifts during the distribution of the questionnaires.

Five hundred (500) questionnaires were distributed to participants in the four mine shafts. One hundred and twenty five (125) questionnaires were distributed in each shaft. Due to the nature of mining, participants requested to fill in the questionnaires at their own convenient time. The questionnaires were completed over the period of eighteen (18) days contrary to the researcher's same day of distribution initial intent. This demanded that the researcher and research assistants collect the completed questionnaires on daily basis or at least remind those who had not completed of the need to do so.



3.9 DATA ANALYSIS

The data collected from underground mine workers was captured and analyzed using the package for social sciences (SPSS) version 15.0. Descriptive statistics of data, namely frequencies expressed as percentages were used to obtain information on the prevalence of WMSIs, body parts injured and number of workers exposed to ergonomic and psychosocial hazards. Inferential statistical analysis was used to determine the associations between risk factors (personal, ergonomic and psychosocial) and injury. This was done in the form of cross-tabulations. Associations between variables were evaluated by means of the chi-square test. Alpha level was set at 0.05. Comparisons between more than two means like age and experience categories in relation to injury

were done by analysis of variance (ANOVA). Data was summarized in terms of percentages and frequencies and presented in form of bar charts, graphs and tables. Results were significant at $P < 0.05$ level.

3.10 ETHICAL CONSIDERATION

Following the approval of the research by the Higher Degrees Committee of the University of the Western Cape as well as the ethical permission to conduct the study from the Research and Study Grant committee (Appendix A), the researcher requested permission to conduct the study from the MCM management (Appendix B) as well as the MMMD (Appendix D). Owing to the privatization of the mines in Zambia, permission to conduct a study on Mopani Copper Mines could only be granted by the mine management while the Ministry of Mines and Minerals Development only granted the researcher access to the Department of Mines Safety for the secondary data needed to supplement the information collected from mine workers.

Written feedbacks were obtained from both the MCM management (Appendix C) as well as the MMMD (Appendix E). In addition, written consent was sought from mine workers (Appendix G). The aim of the study was well explained by both the researcher and research assistants to all relevant parties and participants were assured of anonymity as well as their right to withdraw from the study at any time without any loss or harm. To ensure anonymity, only numbers were used for participants. If any participant presented with injury, measures were put in place to ensure appropriate referral to the health practitioners at the mine hospital.

CHAPTER FOUR

RESULTS

4.1 INTRODUCTION

An overview of the results obtained in the study is presented in this chapter. The results of the study are presented in two sections. Section A presents the results from mine workers whereas section B presents the supplementary information collected from the Republic of Zambia Mine Safety Department. In section A the results are presented under various headings, which reflect the objectives of the present study. Prior to the objective results, the response rate, age, experience and occupation are presented as sample demographic characteristics. The headings reflect a general picture of the Zambian mining industry by giving the general prevalence of work-related musculoskeletal injuries (WMSIs), distribution of WMSIs in various age groups, work experience and occupations. The most affected body regions are also given. Finally, participants' reported ergonomic and psychosocial risk factors to musculoskeletal injuries as well as their attributions of WMSIs are given.

Section B presents the injury perspective of the Mine Safety Department, injury distribution in various mine occupations, the most affected body parts and their related mechanisms. The section ends with the injury prevention strategies of the Mine Safety Department. Data is presented in the form of graphs, charts and tables. The description of the most salient sample characteristics is presented in percentages and frequencies.

4.2 SECTION A: DEMOGRAPHIC CHARACTERISTICS OF MINE WORKERS

4.2.1 Sample response rate

A total of 500 questionnaires were provided to mine workers, out of which 202 were properly completed. This yielded a 40.4% response rate. Two hundred and ninety eight (298) were misplaced or not returned. All the participants in this study were male underground mine workers as there were no female mine workers under ground.

4.2.2 Demographic characteristics of participants

The demographic data of participants are presented in Table 4.1 below and includes age, years of experience and occupation. The mine workers who participated in the study were aged between 23 and 60 years old (mean=40.31; SD=8.572 years). A total of 0.9% (n=2) did not indicate their age. The experience of mine workers ranged from 1 to 35 years (mean=13.92 years; and SD=9.743 years). Table 4.1 below illustrates that most mine workers had less than 5 years of work experience (n= 82, 40.2%).

The sample considered in this study constituted mine workers from 7 main occupations, each of them representing those who perform similar work under similar working conditions. Mine workers involved in supervisory and mechanic work comprised a larger part of the study sample, representing 20.3% (n=41) and 18.8% (n=38) respectively. This is due to these job types having larger numbers of mine workers than others. The low frequencies were evident in the number of locomotive and diesel loader drivers with 5 (2.5%) and 24(11.9%) respectively.

Table 4.1. Sample distribution of employees regarding their age, experience and occupation (n=202)

Variable	Characteristics	Frequency	Percentage
Age (Years)	<35	57	28
	35-45	82	41
	>45	61	30
	Missing	2	1
Experience (years)	<5	82	40.6
	5-10	53	26.2
	>10	66	32.7
	Missing	1	0.5
Occupation	Electrical work	30	14.9
	Mechanical work	38	18.8
	Diesel loader drivers	24	11.9
	Miners	33	16.3
	Locomotive drivers	5	2.5
	Supervisory	41	20.3
	Others	31	15.5

“Others”: Callout clerks, Bob cat drivers, Draughts men, Pump chamber and Surge bin operators.

4.3 INJURY PREVALENCE

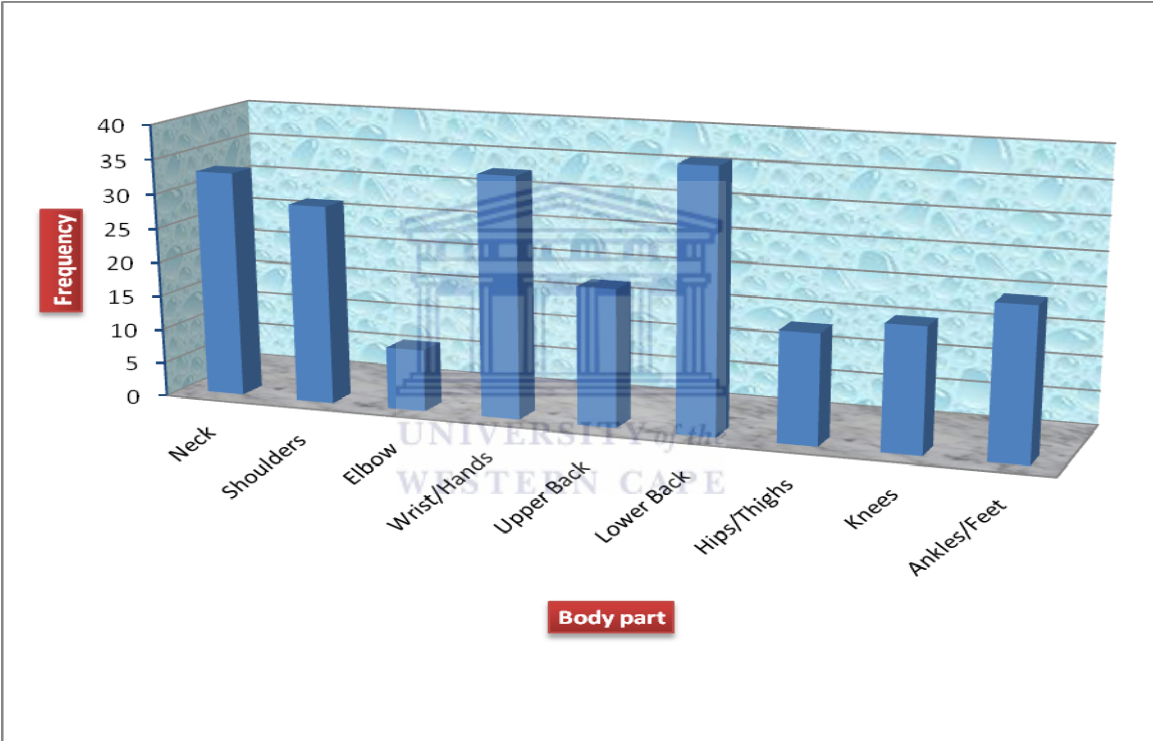
The analysis of data obtained through the Standardized Nordic Questionnaire revealed that 116 (57.4%) of the entire sample did not have work-related musculoskeletal injuries while 86 (42.6%) had sustained at least one injury from mining activities during the preceding one year.

4.3.1 Body parts injured

Figure 4.1 below summarizes the most affected body parts of underground mine workers. The body parts affected the most were the lower back (44.2%, n=38) and the wrists/hands

(40.7%, n=35). In the lower limbs, the most affected parts were the ankles/feet (26%, n=22). The injuries reported in this study showed that the spine (lower back and neck) and upper limbs (shoulder and wrists/hands) were more commonly affected than the lower limbs. Of the total number of injuries reported by mine workers, 48 (56%) were complaints involving multiple injuries; these are injuries involving different body parts.

Figure 4.1. Distribution of most common body parts injured (n=86)



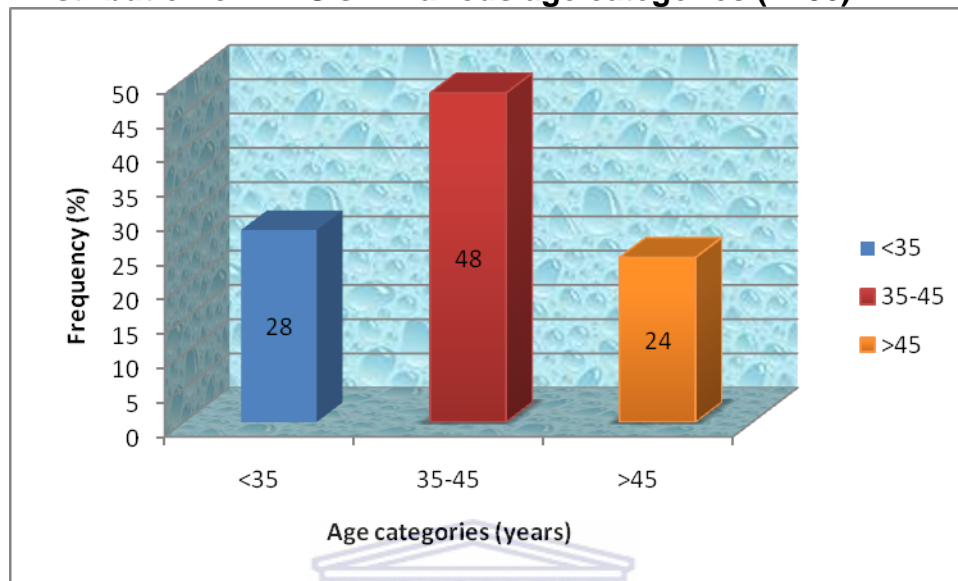
*more than one response permitted

4.3.2 Distribution of WMSIs according to age categories

The study examined age-related injury risks faced by underground mine workers. Three age categories were used and age-related injury frequency examined. High injury ratios were rare among older mine workers (>45 years) but some injury patterns became more frequent

in the middle age group (35-45 years) as shown in figure 4.2 below.

Figure 4.2. Distribution of WMSIs in various age categories (n=86)



The chi-square test indicated a significant association between age and injuries of the knees and ankles, ($p=0.048$) and ($p=0.004$) respectively. Further analysis with a one-way analysis of variance was done to compare the mean “injury in the last 12 months” of the three age groups. The results depicted in Table 4.2 below indicate a statistically significant difference between the three age categories ($F(2, 81) = 212.45, p < 0.01$). Post-hoc comparisons were used to detect exactly which group differs from the other groups. Post-hoc analysis using Scheffe’s test indicated significant differences in mean “injury in the last 12 months” between mine workers in all age groups ($P < 0.05$).

Table 4.2. Mean scores on the distribution of WMSIs in various age categories

AGE	N	Mean	Std. Deviation	F	P
<35 years	24	30.42	2.701	212.448	.000**
35-45 years	40	41.08	3.261		
>45 years	20	50.80	3.901		

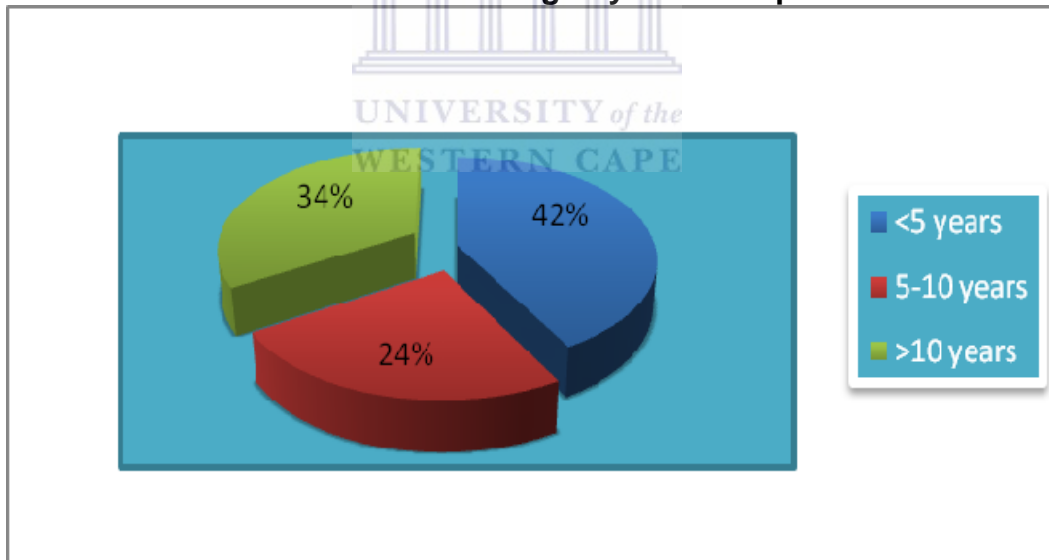
Total	84	40.35	8.100		
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**P<0.05 Scheffe's Test

4.3.3 Distribution of WMSIs according to work experience categories

The figure below shows the distribution of bodily injuries in various work experience (length of time as mine worker) categories. The number of injuries sustained in each work experience category was recorded. Figure 4.3 illustrates that of the 86 injured workers, the highest prevalence of WMSIs was amongst mine workers with less than 5 years experience (42%), while those with 5 to 10 years of work experience (24%) had the lowest number of injuries.

Figure 4.3. Distribution of WMSIs according to years of experience



The chi-square test was used to determine an association between WMSIs and length of time spent as a mine worker (work experience). The results showed that there was no significant association between WMSIs and work experience ($p=0.863$). Further, a one-way ANOVA was used to compare the mean “injury in the last 12 months” of the three groups.

The results depicted in Table 4.3 below indicate a statistically significant difference between the three groups ($F(2, 83) = 137.87, P < 0.01$). Post-hoc analysis using Scheffe's test indicated significant differences in mean "injury in the last 12 months" between mine workers with more than 10 years of work experience ($M=19; SD=6.6$) and those who had 5-10 years of experience ($M=7.28; SD=1.81$) or less than 5 years work experience ($M=2.52; SD=1.1$) ($P < 0.05$).

Table 4.3. Mean scores on WMSIs according to years of experience

Years of service	N	Mean	Std. Deviation	F	P
< 5 years	36	2.519	1.0417	137.865	.000**
5-10 years	18	7.278	1.8087		
>10 years	32	19.000	6.5501		
Total					

**P<0.05

4.3.4 Distribution of WMSIs according to mine occupations

Table 4.4 below summarizes the injury frequencies in various mine occupations. Among the occupations, those presenting with the highest number of injuries were mechanics and supervisory, each reporting 19 (22.1%), while the least number of injuries were noticed among diesel loader drivers with 8 (9.3%) and no injuries were reported among locomotive drivers. There was no significant association between the type of occupation and injury for the overall group ($p=0.25$).

Table 4.4. Distribution of WMSIs in various mine occupations (n=86)

Occupation	Injury frequency	Percentage (%)
Electrical work	16	18.5
Mechanical work	19	22.1
Diesel loader drivers	8	9.3
Miners	13	15.1
Locomotive drivers	0	0

Supervisory	19	22.1
Others	11	12.8
Total	86	100

"Others": Callout clerks, Bob cat drivers, Draughts men, Pump chamber and Surge bin operators

4.3.5 Body part injury by occupation

Table 4.5 below shows the body part injury distribution among various underground mining occupations. The body parts with the highest injury reports in each occupation are highlighted.

Table 4.5. Percentage of body part injury per occupation (n=86)

Affected body part	Title of occupation						
	Electrician	Mechanic	loader driver	Miner	Loco. Driver	supervisory	Others
Neck	6(20%)	8(21%)	3(13%)	7(21%)	0(0%)	5(13%)	4(13%)
Shoulder	6(20%)	8(21%)	1(4%)	3(9%)	0(0%)	8(20%)	3(10%)
Elbow	2(7%)	0(0%)	1(4%)	2(6%)	0(0%)	2(5%)	2(7%)
Wrists/Hands	5(17%)	8(21%)	1(4%)	8(24%)	0(0%)	8(20%)	5(16%)
Upper back	6(20%)	4(11%)	2(8%)	1(3%)	0(0%)	3(7%)	4(13%)
Lower Back	5(17%)	7(18%)	4(17%)	8(24%)	0(0%)	9(22%)	5(16%)
Hips/Thighs	2(7%)	3(7%)	3(13%)	3(9%)	0(0%)	2(5%)	3(10%)
Knees	3(10%)	4(10%)	3(13%)	4(12%)	0(0%)	3(7%)	1(3%)
Ankles/Feet	3(10%)	4(11%)	5(21%)	3(9%)	0(0%)	3(7%)	4(13%)

* Loco. Driver: Locomotive driver

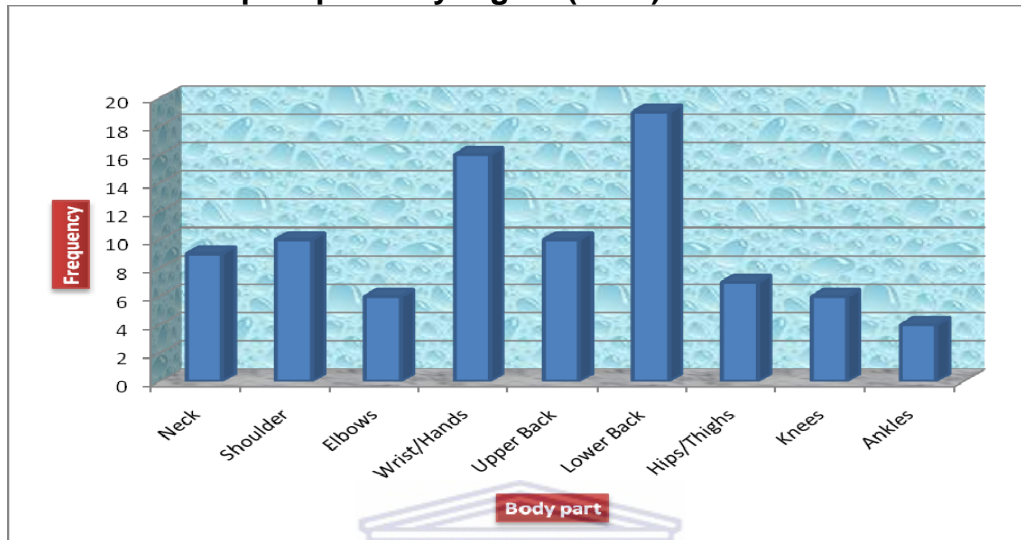
"Others": Callout clerks, Bob cat drivers, Draughts men, Pump chamber and Surge bin operators

The most affected body parts among the mine workers were the wrist/hand, lower back and neck. Electricians sustained the highest number of neck, upper back and shoulder injuries. A similar trend was observed amongst mechanics, where the neck, shoulder and wrist/hands were the body parts affected the most. The majority of loader drivers complained of pain in the ankles/feet. The supervisory category constituting mine

captains, section bosses, senior engineers and senior surveyors reported the shoulder and wrist/hands as the most affected body regions. Finally, the body parts affected the most among the 'others' category were the lower back and wrists/hands. Overall, mechanics reported the highest number of neck and shoulder injuries while miners had the most frequently reported hand/wrist injuries among all underground mine occupations. The highest upper back injuries were observed among electricians while injuries of the lower back were frequently reported by the supervisory. Loader drivers reported the highest number of ankle/feet injuries. Most workers 48 (56%) from various mining job categories reported multiple bodily injuries. A total of 17(89%) workers involved in mechanical work reported multiple injuries while only 7 (44%) electricians reported such injuries. All the 13 (100%) miners had experienced multiple injuries. Of the 8 loader drivers presenting with injuries, 5(63%) reported having experienced multiple injuries in the past one year and 6(32%) were those in the supervisory category. There was no significant association between body part injured and occupation.

Figure 4.4 below depicts the number of workers prevented from doing normal work in relation to body parts injured. The majority of workers have been prevented from doing their normal work due to pain in the lower back and hand/wrists, 19 (22.1%) and 16(18.6%) respectively. The ankle/foot injury had the least number of workers prevented from doing normal work activities 4 (5%).

Figure 4.4. Number of workers prevented from doing normal activities in the last 12 months because of pain per body region (n=86)



4.4 RISK FACTORS

4.4.1 Ergonomic risk factors

In order to provide estimates of safety hazards with regard to common ergonomic hazards to which workers are exposed, mine workers were required to report health hazards for their job types. The mine workers reported exposures to eight (8) different ergonomic hazards. The operational definitions for the eight ergonomic hazards considered in this study are listed in Table 4.6 below. Mine workers were asked to determine if any of the conditions in Table 4.6 were present in their work activities. For many of the risk factors, two conditions were presented, which were the indicators for caution (a lower level of risk) and hazard (a higher level of risk). Most of the conditions are based on duration. The workers were asked to check the length of exposure to an activity which was used to determine whether the condition was caution or hazard. If the

higher condition is met (generally a longer period of time), then hazard is checked. If one or more hazards are identified, a WMSI hazard exists.

Table 4.6. Operational definitions for ergonomic hazards

Heavy lifting (HL): Lifting unaided an object heavier than 25 Kg (55 lbs) more than 10 times per day

Awkward postures (AP): Lifting an object above head level; working with the neck bent more than 30 degrees without support; working with a bent wrist; working with the back bent without support; squatting and kneeling for two or more hours.

High Hand Force (HF): Pinching an unsupported object; grasping unsupported objects; grasping plus wrists bent for two or more hours.

Highly repetitive work (RW): Work involving repeating the same motion with little or no variation every few seconds for two or more hours.

Vibration Tools (VT): Work involving use of vibrating tools such as grinders, jig saws or other hand tools that typically have moderate vibration levels for two or more hours.

Bouncing or Jarring (BJ): Work involving operating mobile equipment for two or more hours.

Static postures (SP): Sitting or standing in a restricted space for two or more hours without changing positions.

Pushing and Pulling (PP): Work involving pushing or pulling against an object, like a trolley with a maximum effort for eight or more times per day.

Table 4.6 adapted from Winn, Biersner and Morrissey (1996).

Table 4.7. Percentage of workforce in each occupation exposed to ergonomic hazards

Variables	Percentage of workforce exposed to							
	HL	AP	HF	RW	VT	BJ	SP	PP
OCCUPATION	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Electrician	21(70)	26(87)	21(70)	11(37)	15(50)	3(10)	14(47)	15(30)
Mechanical	30(79)	25(66)	22(58)	25(66)	25(66)	6(16)	13(34.2)	25(66)
Loader driver	13(54.2)	7(29.2)	6(25)	19(79.2)	5(21)	19(79.2)	15(62.5)	5(21)
Miner	21(64)	12(36.4)	12(36.4)	13(39.4)	10(30.3)	10(30.3)	6(18.2)	14(42.4)
Locomotive drivers	3(60)	1(20)	1(20)	3(60)	1(20)	3(60)	3(60)	2(40)
Supervisory	20(49)	15(37)	11(27)	13(32)	10(24.4)	11(27)	14(34.1)	19(46.3)
Other	15(48.3)	14(45.2)	10(32.3)	9(29)	10(32.3)	5(16.1)	10(32.3)	4(13)

“Others”: Callout clerks, Bob cat drivers, Draughts men, Pump chamber and Surge bin operators

The respondents reported 691 ergonomic hazards among the 7 mining occupations surveyed. Using worker task and facility characteristics, as well as the exposure durations, estimates were made of population exposures to the 8 ergonomic hazards for each mining occupation (Table 4.7). The most common ergonomic hazards reported were heavy lifting (123 exposures), followed by awkward postures (100 exposures) and repetitive work (93 exposures) while bouncing and jarring had the least number of exposures (57).

The chi-square test was done to determine associations between ergonomic risk factors and body part injuries. The following activities were significantly associated with back discomfort: working with the back bent without support was significantly associated with

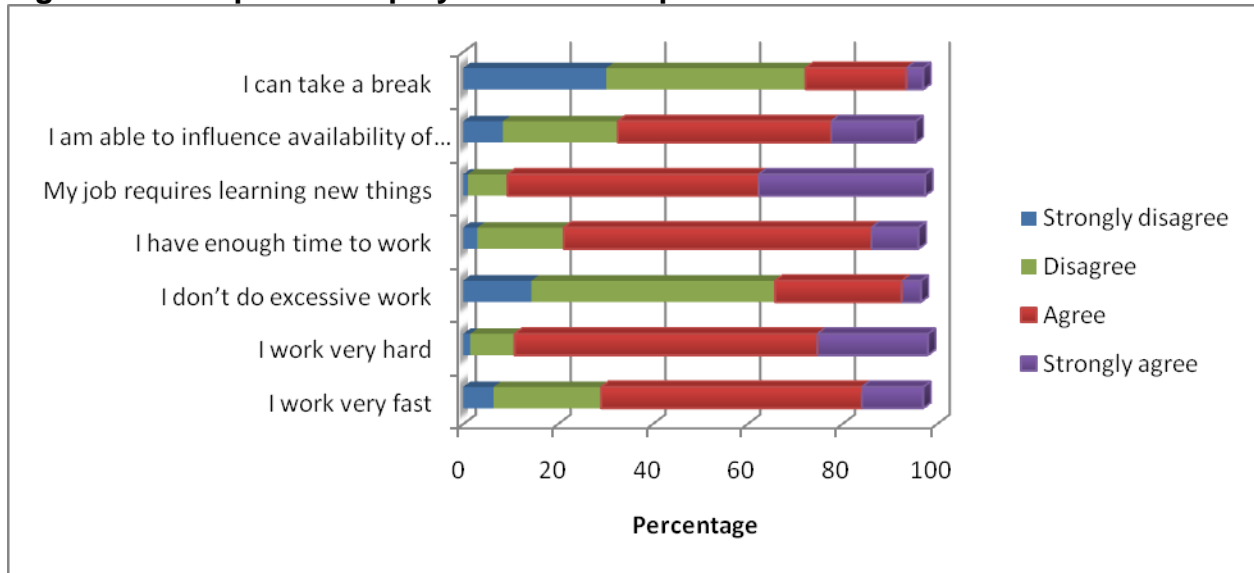
both upper ($p=0.024$) and lower back ($p=0.020$) discomforts. Significant associations were also found between pain in wrists/hands and grasping an unsupported object(s) weighing 5 or more kg per hand or grasping with a forceful grip ($p=0.049$) and grasping objects with wrist bent ($p=0.016$). Participants were also asked whether their job involved use of hand tools with high vibration levels. A significant association ($p=0.022$) was found between wrist injury and use of hand tools such as percussive tools (i.e., jack hammers and chipping hammers), impact wrenches and chain saws.

4.4.2 Psychosocial risk factors

4.4.2.1 Job demand

Figure 4.5 below shows that the majority (64.9%, $n=131$) reported that their job requires working very fast. The figure also shows that most mine workers reported that their job requires working very hard (63.9%, $n=129$) and learning new things (53.0%, $n=107$). A good number of workers (51.5%, $n=104$) disagreed they are not asked to do an excessive amount of work. Eighty five (85) (42.1%) disagreed they can not take a break whenever they need to. Regarding equipment, 91(45.0%) agreed they are able to influence the availability of equipment needed to do their work.

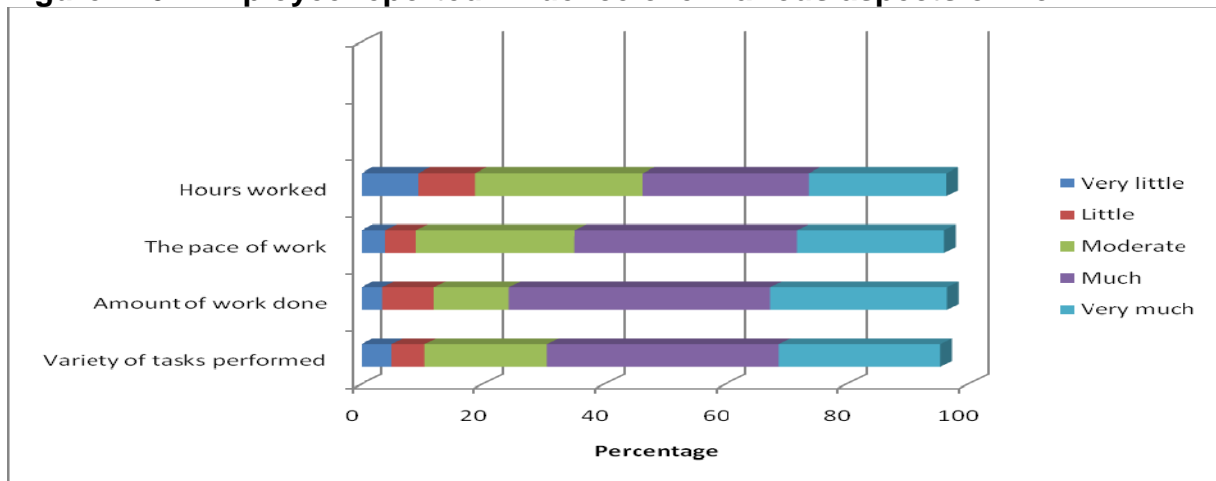
Figure 4.5. Reported employee Job descriptions



4.4.2.2 Control at work

As indicated in the figure below, most workers (38.1%, n=77).reported having much influence over the variety of tasks they perform. Workers also reported having moderate to much control and influence over the amount of work, the pace of work and the hours worked and relatively few workers reported very little to little control and influence.

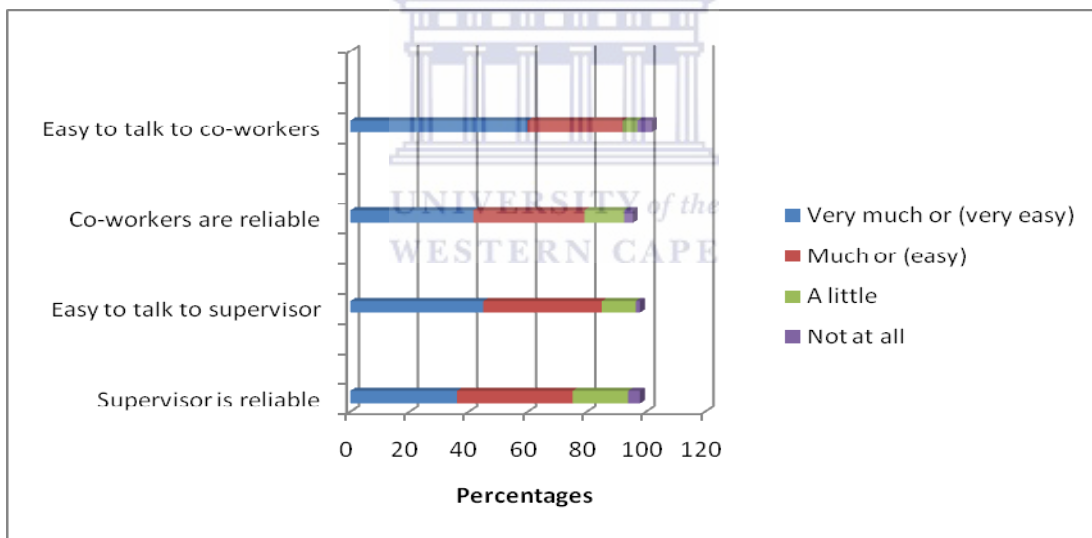
Figure 4.6. Employee reported influence over various aspects of work



4.4.2.3 Work relationships

Generally, mine workers reported a good relationship with their supervisors and co-workers as indicated in figure 4.7 below. Very few mine workers reported receiving little or no support from their supervisors and co-workers. For example, only 8(4%) reported their supervisors as unreliable when things get tough at work. Concerning co-workers reliability and interpersonal communication in times of need, 6 participants (3%) felt their co-workers were not supportive. 79(39.1%) and 84(41.6%) reported receiving very much support from their supervisors and co-workers respectively.

Figure 4.7. Work relationships as reported by employees

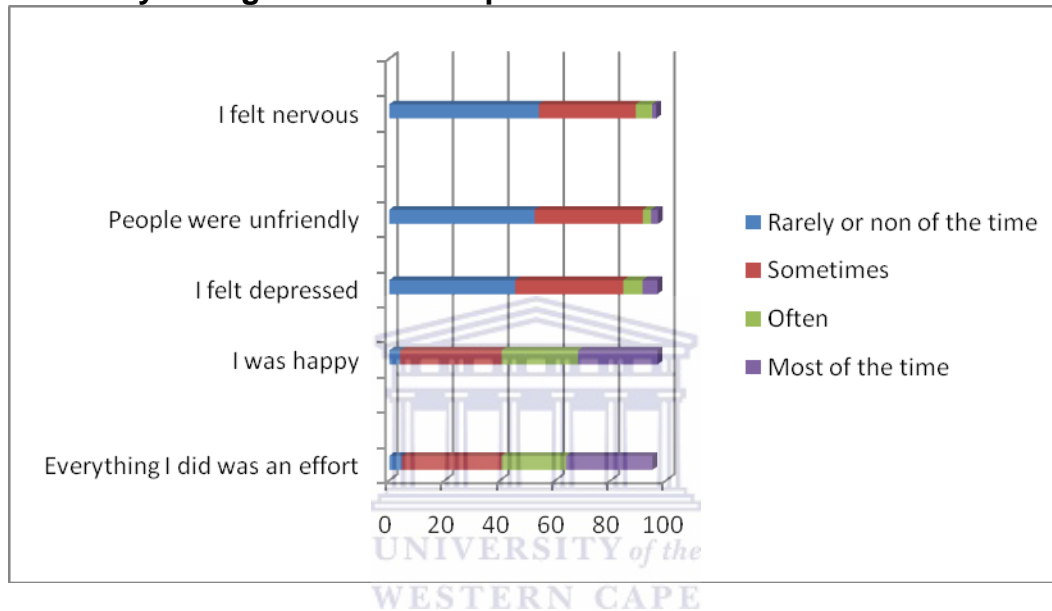


4.4.2.4 Psychological distress

As indicated in figure 4.8 below, the majority of the participants reported that they sometimes felt everything they did was an effort 73(36.1%), and 74(36.6%) were sometimes happy, while 63(31.2%) felt that everything they did was an effort most of the time and 8(4%) were rarely happy with work. Regarding depression, 79(39.1%)

sometimes felt depressed and 92(45.5%) never experience the feeling of depression. 79(39.1%) of the employees felt that people are sometimes unfriendly while 106(52.5%) felt people were rarely unfriendly. Some workers 71(35.1%) sometimes felt nervous at work in the past one month.

Figure 4.8. Psychological distress reports

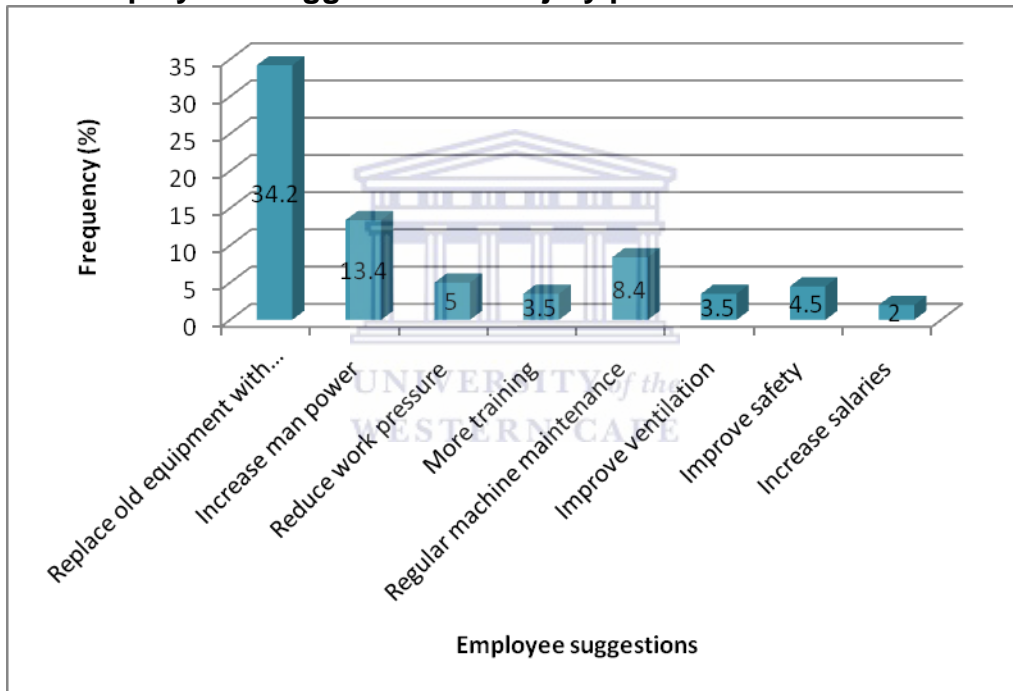


The Chi-square test of associations was done between all psychosocial risk factors and prevalence of work-related musculoskeletal injuries. The test showed that working very fast and insufficient time to do work is significantly associated with injury, ($p=0.010$) and ($p=0.003$) respectively. A significant association was also found between injury and level of training ($p=0.012$). There was no significant association between injury and work relationships and psychological distress.

4.5 PREVENTION OF WORK-RELATED MUSCULOSKELETAL INJURIES

Figure 4.9 below depicts mine workers' suggestions of preventive measures. The majority of mine workers suggested that all old equipment must be replaced with modern ones 69(34.2%) and increase of work force 27(13.4%) while salary increase had the lowest frequency 4(2%). These were suggested by mine workers as the most likely preventative measures for work-related musculoskeletal injuries.

Figure 4.9. Employees' suggestions for injury prevention



4.6 SECTION B: INJURY PERSPECTIVE OF THE MINE SAFETY DEPARTMENT OF KITWE, ZAMBIA

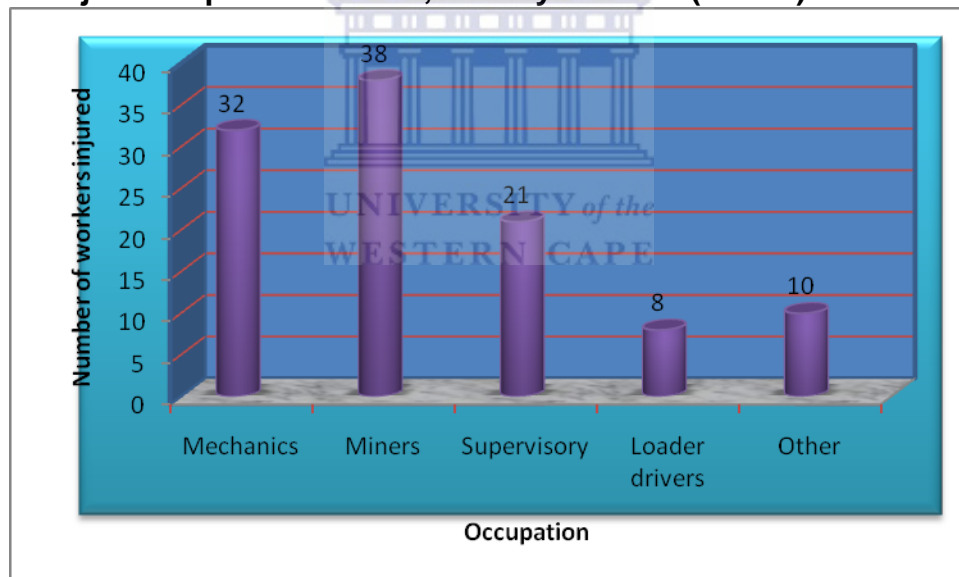
Secondary data was collected from the Mines Safety Department (MSD) in Kitwe, Zambia. The data was to supplement the information collected from the mine workers at Nkana underground mine given the low response incurred during the study. The researcher was given access to all the “reported injury records” and extracted data on

the prevalence of work-related musculoskeletal injuries (WMSIs) amongst underground mine workers at Nkana underground mines for the year 2007. The data extracted included injury causes and mechanisms and most affected body parts.

4.6.1 Prevalence of WMSIs for the year 2007

The reported injury data from the MSD showed an injury prevalence of 109 out of the total of 1896 employees (6%). Figure 4.10 below illustrates the distribution of injuries among various mine occupations. The mine workers with the highest number of injuries were miners 38(35%) while loader drivers reported the lowest 8(7.3%).

Figure 4.10. Injuries reported to MSD, in the year 2007 (N=109)



4.6.2 Most affected body parts

The most injured body parts were the wrist/hand/fingers and constituted a total of 38% of all injuries reported to the MSD. This was followed by the ankle/feet and knee with 23%. The head/facial injuries alone had 12% of complaints reported. The other reported

parts included shoulder 11%, elbow/forearm 7%, hip/ thigh 5% .The smallest percentages (4%) were reported injuries of the back.

4.6.3 Mechanism of injury

According to the MSD injury database, rock falls from both the roof and side of the underground rooms was the main cause of the injuries, constituting 53% of the injuries, followed by being hit by equipment like scotch cars and use of hand tools (shovels, jack hammers, spanners and picks) (41%). Equipment related injuries also included equipment repairs as source of injury. 6% of the injuries were attributed to slips and falls.

4.6.4 Injury prevention strategies of the Mine Safety Department

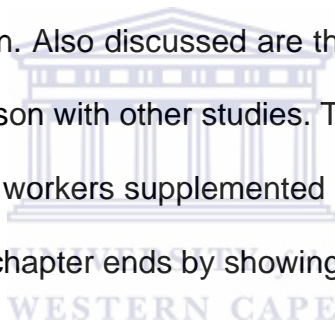
According to regulation 301 part III (d) of the Guide to the Mining Regulations (1973), one of the responsibilities of the MSD is “to examine into and make enquiries respecting the state and condition of any mine or part thereof, and of all matters and things pertaining thereto, in so far as they relate to the safety or health of persons employed therein”. However, according to one of the senior inspectors of mines, the MSD has not been able to meet ideal safety standards in the mines because of lack of skilled labor force. The MSD records show that there are only 8 qualified mine inspectors in the whole country. In this regard, the MSD has proposed a three year rolling staff training to equip all junior inspectors with skills in risk assessment, winding plant, prosecution and environmental air pollution management.

CHAPTER FIVE

DISCUSSION

5.1 INTRODUCTION

The aim of this study was to determine the prevalence of and risk factors contributing to work-related musculoskeletal injuries (WMSIs) amongst underground copper miners in Kitwe, Zambia. This chapter discusses the prevalence of and risk factors associated with WMSIs by giving the injury prevalence and risk in various age, experience and mining occupation categories. The most reported physical and psychosocial risk factors are also taken into consideration. Also discussed are the most affected body parts. The discussion is based on comparison with other studies. The findings are the results of the information collected from mine workers supplemented by the information from the mine safety department (MSD). The chapter ends by showing the limitations of the study.



5.2 FINDINGS ON DEMOGRAPHIC CHARACTERISTICS

The response rate of 40.4% in this study was low compared to rates reported in other studies (Maiti, Chatterjee & Bangdiwala, 2004; Paul & Maiti, 2007; Torma-Krajewski, Steiner, Lewis, Gust & Johnson, 2007). The mean age of the mine workers was 40.31 years with a standard deviation of 8.57 years. This large standard deviation signifies a big deviation in the age of mine workers, which means that the majority was aged between 32 and 49 years old. Therefore, the age range and moderate standard deviation compared to the mean indicate that the majority of the Zambian mine workers are in the middle age group (35-45). Regarding experience, the mine workers had

adequate work experience as revealed by the study with the mean of 13.92 years. The demographic findings in this study are in line with findings reported in similar studies (Ghosh, Bhattacharjee & Chau, 2004; Bio et al., 2007; Paul & Maiti, 2007). Paul and Maiti (2007) and Bio et al. (2007) reported mean ages of 37.34 and 40 years respectively. These authors also reported work experience mean durations of between 14 and 15 years. Regarding gender, all participants in this study were male as also reported by Ghosh, Bhattacharjee and Chau (2004) and Bio et al. (2007)

5.3 IDENTIFICATION AND DESCRIPTION OF INJURY PREVALENCE

The results of this study revealed a lower prevalence (42.6%) of work-related musculoskeletal injuries (WMSIs) amongst mine workers than reported in similar studies (Komljenovic, Groves, & Kecojevic, 2007; Karra, 2005; Hull, Leigh, Driscoll & Mandryk, 1996). The prevalence found in this study was however higher than those reported among South African gold, platinum and coal mine workers by Dias & Shutte (2005). The definition of injury and injury prevalence adopted in this study was different from those used in some of the other studies. In this study, injury was defined as injuries of the musculoskeletal system (i.e. Muscles, joints, ligaments, tendons and nerves) according to Dias & Shutte, (2005), and injury prevalence was calculated from the total of mine workers who at least, sustained one or more WMSI at any time in the past 12 months. These definitions limited the comparability of this study with many similar studies because the other studies defined injury as one, resulting in one or more days lost from work (Hull, Leigh, Driscoll & Mandryk, 1996; Coleman & Kerkering, 2007) while prevalence was defined as injury rate per 100 000 mine workers, (Groves, Kecojevic &

Komljenovic, 2007; Komljenovic, Groves & Kecojevic, 2008), number of injuries per 1000 persons (Loewenson, 2001; Maiti, Chatterjee & Bangdiwala, 2004; Paul, Maiti, Dasgupta & Forjuoh, 2005) and number of injuries per 100 mine workers (Hull et al., 1996). The raised issues of injury and injury prevalence definitions could not be ruled out due to the nature of this study. It is evident that there is a need to find a common definition that can be used in research for WMSIs that would facilitate the process of monitoring the prevalence of these injuries and evaluating interventions aimed at improving the situation.

5.4 BODY PARTS INJURED

The body parts susceptible to WMSIs did not differ from those found in various literatures. The results yielded in this study agree with a study conducted by Punnett and Wegman (2004) which reported the lower back, neck, shoulders and hands as body regions commonly involved in WMSIs. In the present study, injury was most frequently reported in the lower back as was also found in previous studies (Sari et al., 2004; Wiehagen & Turin, 2004; Dias & Shutte, 2005; Moore, Bael & Steiner, 2007; Torma-Krajewski, Steiner, Lewis, Gust & Johnson, 2007). The findings of the present study as regards injuries of the lower back agree with similar studies that have found back injuries as representing 32-87% of the total injuries incurred by underground mine workers (Dias & Shutte, 2005; Bio et al., 2007; Moore, Bael & Steiner, 2007). In contrast, the data retrieved from the MSD showed that back injuries were the least reported. The contrast from the MSD data could be explained by the fact that only injuries resulting in a minimum of 3 days of lost work are reported to the MSD and due

to possible underreporting as reported in a previous study (Vuuren, Zinzen, Heerden, Becker & Meeusen, 2005). Furthermore, contrary to studies conducted by Sari et al. (2004), Wiehan and Turin (2004), Dias and Shutte (2005), Moore, Bael and Steiner (2007) which reported that the knee was the most affected joint after the back. The present study found the wrists/hands 35(40.7%) as the second-most-common injury, possibly due to high levels of repetitive bending and twisting of the hand/wrist. According to the MSD data, the wrist/hand had the highest injury frequency in a relatively similar fashion (38%). The study also found that the ankle/feet were the most affected part of the lower limbs as also indicated by MSD data. In addition to that, the findings indicated that the supervisory and miners presented a higher prevalence of low back pain than the other occupations. This finding is consistent with the study by Dias and Schutte (2005) which found the majority of backache complaints among miners (rock drill operators and winch operators) at two South African mines. The study also found the mechanics and miners with the highest prevalence of wrists/hands injuries among all underground mine occupations. The current study also found that the majority of workers have been prevented from doing their normal work due to back pain, followed by shoulder and wrists/hands.

5.5 PERSONAL RISK FACTORS

The Chi-square test indicated that there was no significant association ($p=0.16$) between age and sustaining an injury. Similar findings have been reported in various studies (Maiti & Bhatacherjee, 1999; Sari et al., 2004; Laflamme, Menckle & Lundholm, 1996; Groves et al., 2007). These findings were consistent with the assumption that

older workers are more likely to be more experienced and hence show a significantly lower risk of injury. This result also means younger mine workers experience a much higher injury rate than the older ones. Equally, it seems that the worker's experience on the same job site entails an increase of acquaintance with one's duties, reducing the probability of an injury. The percentage distribution of injured persons regarding the variable age indicates that the majority (48%) of WMSIs amongst underground mine workers occurred in the middle age group (35-45 years). It seems that experiencing an injury in between the ages of 35 and 45 years is more probable than in the other age groups. In light of this finding, the present study supports the assertion that the middle age group is a risk group for WMSIs as reported in other studies (Salminen, 2004; Bio, Sadhra, Jackson & Burge, 2007; Lin, Chen, & Luo, 2008). In contrast, Paul and Maiti, (2007) found a direct positive relationship between age and injury. In their study, it was concluded that aged workers are more liable to be involved in injuries. The contrasts from these authors could be as a result of a relatively young group of workers studied (Mean=37.34). Given the concentration of the mining workforce in this age interval, it could be assumed that excessive injury frequency in the 35-45 year age interval is either a sign of risk factors for that age group or that the injured workers' age interval and mine general workforce age interval may show almost similar distribution and consequently, the medium age group of 35-45 years showed the same peak fashion among injured workers.

Regarding the association between work experience as a mine worker and WMSIs, the results showed that there was no significant association between the occurrence of an injury and number of years working as a mine worker ($p=0.863$). This finding is

consistent with those reported in previous studies (Hull, Leigh, Driscoll & Mandryk, 1996; Paul & Maiti, 2007). The percentage distribution of injured persons in relation to work experience indicates that the majority (40.6%) of WMSIs amongst underground mine workers occurred during the first five (5) years of employment. This result agrees that inexperience is related to a high injury rate (Jeong, 1997; Chi, Chang & Hung, 2004; Salminen, 2004; Fabiano, Curro, Reverberi & Pastorino, 2008). As reported by Salminen, (2004) and Fabiano, Curro, Reverberi and Pastorino, (2008) reasons are to be traced to lack of experience in the activity, insufficient specific knowledge (formal and informal knowledge) about a particular job activity and to inadequate training periods. It could therefore be assumed that mine workers with five (5) years or less experience were at a considerably higher-than-average risk.

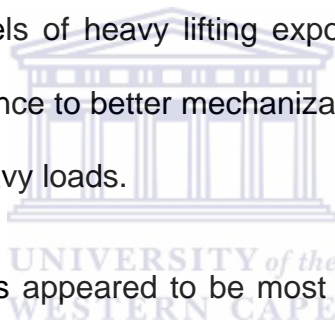
The variable occupation in this study did not have any significant association with the occurrence of an injury ($p=0.25$). This reveals that there was no significant difference in job categories in terms of injury occurrence. However, the study found that most of the workers frequently injured, belong to mechanics 19 (22.1%), supervisory 19 (22.1%), electricians 16(18.6%) and miners 13 (15.1%) as also indicated by MSD data. These were the highest occupational risk groups for WMSIs among mine workers in this study. The findings of this study are consistent with other studies (Maiti & Bhattacharjee, 1999; Sari, Duzgun, Karpuz & Selcuk, 2004; Bio, Sadhra, Jackson & Purge, 2007). Previous studies have also found that the mechanical unit men sustained more injuries than other trade persons (Hull, Leigh, Driscoll, & Mandryk, 1996; Bio et al., 2007). This could be due to the nature of underground mechanical work which involves lifting heavy machinery parts (Bio et al., 2007), and may indicate a higher risk of WMSIs than other

mine occupations. Sari et al. (2004) reported an increase in the injury rates of the mechanics, electricians and miners in the mechanized panels. According to Leigh et al. (1990) cited by Sari et al. (2004), the majority of injuries (70%) in underground mines were sustained by the supervisory and miners while the mechanics and electricians took second place with 26%. Barry and associates (1971) cited by Sari et al. (2004), also found the mechanics and supervisory among the most hazardous occupations.

5.6 ERGONOMIC RISK FACTORS

Literature shows that ergonomic hazards for musculoskeletal injuries in the mines include highly repetitive motions, forceful exertions, vibration exposures, poor/awkward posture, forceful gripping and jolting/jarring (Wilder, Pope, & Magnusson, 1996; Wiehagen & Turin, 2004; Punnett & Wegman, 2004; Karra, 2005). This is specifically evident in the industrially developing nations where manual labor involved in physically demanding tasks is a dominant factor and where manual handling involving lifting of heavy burdens is inherent within the industry despite the industrial mechanization (Bio et al., 2007). In the current study, mine workers from different occupations reported health hazards for their job types. The mine workers reported exposures to eight (8) different ergonomic hazards namely; heavy lifting, awkward postures, high hand force, highly repetitive work, vibration tools, bouncing or jarring, static postures and pushing/pulling. The present study found high levels of heavy lifting, awkward postures, forceful gripping, pushing/pulling and highly repetitive work. The least reported exposure was bouncing and jarring. These findings are in part consistent with the findings of Torma-Krajewski, Hipes, Steiner and Burgess-Limerick (2007). However, these authors

also reported high levels of bouncing/jarring which, in the present study, was the least reported. This could be explained by the difference in the job type composition of the samples and variation in the degree of mechanization between the western and developing countries. Torma-Krajewski, Steiner, Lewis, Gust and Johnson (2007) reported repetition as the most frequent risk factor exposure, followed by heavy lifting and forceful gripping whereas vibration had the least reported exposures. In the present study, heavy lifting was the most frequently reported risk factor followed by awkward posture and repetition. It could be assumed that developed countries have better work policies and hence preventative programmes like ergonomics are well implemented. Regarding the relative low levels of heavy lifting exposures in western countries, the researcher attributes the difference to better mechanization than in developing countries where many workers still lift heavy loads.



Exposure to ergonomic hazards appeared to be most prevalent for the following body parts; back, shoulders, neck and hands/wrists. The study found that the majority of mechanics 30(79%) reported exposures to heavy lifting. These workers reported lifting unaided an object heavier than 25 Kg (55 lbs) more than 10 times per day. However, not only mechanics, but also other mine workers like electricians 21 (70%), miners 21 (64%) and supervisory 20(49%) reported high exposures though in relatively low frequencies. Bio et al. (2007) stated that underground engineering involves the lifting of heavy machinery parts. Regarding awkward postures, electricians 26(87%) and mechanics 25(66%) reported the highest exposures. These engineering occupations involve lifting, fitting and pushing objects for long durations and thus are likely to be more exposed to awkward postures like working with the neck bent, working with hands

above the head, working with the back bent and kneeling, than their counterparts. Mechanics and electricians also reported high exposures to high hand force, 22(58%) and 21(70%) respectively. In addition, the present study found significant associations between pain in wrists/hands and grasping an unsupported object weighing 5 or more kg per hand or grasping with a forceful grip ($p=0.049$) and grasping objects with the wrist bent ($p=0.016$). These findings are consistent with those reported by Torma-Krajewski, Steiner, Lewis, Gust and Johnson (2007). These authors further reported that holding hand gadgets like impact wrenches results in sore hands. The highest frequencies of repetitive work was as expected prevalent amongst loader drivers 19(79.2%) followed by mechanics 25(66%) due to the nature of their job. When the use of vibrating tools was considered, mechanics reported the highest exposure 25(66%) while electricians reported 15 (50%) exposure to vibration. This could be as a result of the frequent use of tools that typically have high vibration levels like impact wrenches, chain saws and percussive tools like chipping hammers and jack hammers. A significant association ($p=0.022$) was found between wrist injury and use of hand tools. Miners, supervisory and the 'other' category reported exposure frequencies in similar frequencies, 10(31%), 10(24.4%) and 10(32.3%) respectively. The loader and locomotive drivers reported the highest exposures to bouncing/jarring and static postures 19(79.2%) and 15(62.5%), and 3(60%) and 3(60%) respectively. This could be necessitated by poor conditions of loaders and locomotives as reported by the majority of mine workers. McPhee (2004) found that the type of vehicle, its speed and condition as well as the condition of roads strongly influence ride roughness. Regarding exposure to work involving pushing or pulling against an object, like a trolley, with a maximum

effort for eight or more times per day, mechanics 25(66%) and 19(46.3%) had the most frequent exposures. As indicated earlier, mechanical work involves handling heavy burdens. In addition, Dias and Schutte (2005), found bending and twisting at the waist significantly associated with back pain. The present study also found working with the back bent without support significantly associated with both upper ($p=0.024$) and lower back ($p=0.020$) discomforts.

The findings of the current study are consistent with other studies (Winn, Biersner & Morrissey, 1996; Torma-Krajewski et al., 2007; Burgess-Limerick et al., 2007; Dias & Schutte, 2005), indicating that the presence of ergonomic risk factors is associated with the development of WMSIs.



5.7 PSYCHOSOCIAL RISK FACTORS

Psychosocial factors have also been implicated by many researchers in the causation of WMSIs. In the current study, associations were done between some psychosocial factors reported in literature and injury occurrence. This study found working very fast and insufficient time to do work, significantly associated with injury occurrence, ($p=0.010$) and ($p=0.003$) respectively. This is consistent with other studies (Bongers, Winter, Kompier, & Hildebrandt, 1993; Dembe, Erickson, Delbos & Banks, 2005). Bongers et al. (1993) reported a relationship between time pressure and injury occurrence. In addition, Dembe et al. (2005) found that working in jobs with overtime schedules was associated with 61% higher injury hazard rate compared to jobs without overtime. This is typical of the mining industry where workers work in shifts. A significant

association was also found between level of training and sustaining an injury ($p=0.012$). Maiti, Bhattacharjee and Bangdiwala, (2004) and Macfarlane, Hunt and Silman (2000) identified dissatisfaction with support from colleagues or supervisors as a work-related psychosocial risk factor. The current study found no significant relationship between interpersonal relationships at work and injury occurrence. The findings of the present study are also in parallel with another study (Ghosh, Bhattacharjee & Chau, 2004) reporting that workers with emotional instability have a higher risk of occupational injuries.

5.8 PREVENTION OF WORK-RELATED MUSCULOSKELETAL INJURIES

The majority of the mine workers in the present study suggested that replacing old equipment with modern ones and increasing the workforce would make their work easier and less risky. This finding agrees with the results reported in a previous study (Bio et al., 2007) regarding mine workers suggestions for injury prevention. The suggestion for better machinery is also in line with the proposition made by Groves et al. (2007), regarding the employment of technological advances to better control and eliminate hazards. The suggestion made by employees to increase the workforce may be as a result of exposure to work overloads and material handling of heavy loads. Material handling accounts for 54-71% of all injuries sustained by mine workers (Sari et al., 2004; Groves, Kecojevic & Komljenovic, 2007). Regular machine maintenance had the third highest frequency among the suggestions made by employees. The observation made by the mine workers regarding irregular machine maintenance, could be as a result of the MSD not having enough staff to conduct regular risk assessments in the mines.

CHAPTER SIX

SUMMARY, CONCLUSION, RECOMMENDATIONS AND LIMITATIONS OF THE STUDY

6.1 INTRODUCTION

In this final chapter, a concise summary of the study is provided. Details of the major issues in the study are given in the conclusion, and thereafter some recommendations are proposed. The chapter ends with limitations encountered in this study.

6.2 SUMMARY

The aim of the present study was to determine the prevalence of and risk factors contributing to WMSIs amongst underground mine workers at Mopani Copper Mines in Kitwe, Zambia. To realize this aim, identification and description of injury prevalence have been made, and possible contributory factors have been investigated.

The findings of this study revealed a prevalence rate of 42.6% and that the most affected body parts were the lower back followed by the hands/wrists. The study revealed that age, occupation and experience had no significant causal effect on injury occurrence, though mine workers in the 35-45 age category and those with less than 5 years experience, reported more injuries than their counterparts. The study also revealed a significant association between injury and ergonomic factors, like working with the back bent and grasping objects. In this study, psychosocial factors such as

working very fast, insufficient time to do work and level of training were significantly associated with sustaining an injury.

The study also revealed mechanics and supervisory as occupations presenting with the highest number of injuries. Overall, mechanics reported the highest number of neck and shoulder injuries while miners had the most frequently reported hand/wrist complaints. The highest upper back complaints were observed among electricians and the supervisory had the largest number of lower back problems. Loader drivers reported the highest number of ankle/feet injuries. It was revealed that the majority of mine workers were prevented from doing their normal work as a result of injuries of the lower back and hand/wrists.

Finally, in order to reduce the occurrence of WMSIs, the majority of mine workers suggested that old equipment should be replaced with modern ones and that the mine management should consider increasing the workforce. According to the mine workers, these were the most likely preventive measures for WMSIs.

6.3 CONCLUSION

Work-related musculoskeletal injuries are highly prevalent to necessitate an urgent intervention. It is envisaged that the identification of factors responsible for WMSIs in this study will inform the design of effective prevention programs in the Zambian mining sector. It is also evident that the identification of the body regions at risk in this study is essential in assisting with identifying aspects of the tasks to which control measures should be targeted.

A combination of interacting work-related ergonomic and psychosocial factors has shown associations with WMSIs, including working with the back bent without support, prolonged use of hand tools, grasping an object weighing 5 or more kg per hand or grasping with a forceful grip, grasping objects with bent wrists for 2 or more hours per day, working very fast, level of training and insufficient time to do work. Despite the conflict in literature, most researchers agree that the epidemiology linking physical ergonomic exposures at work with risk of WMSIs is methodologically adequate to inform primary prevention. The effects of psychosocial stressors were generally less pronounced. However, certain psychosocial stressors like job control, inadequate rest breaks and support from superiors were nearly as high.

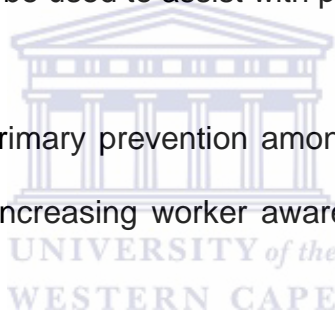
It is likely that the largest number of back injuries in the supervisory and mechanics is influenced by the work place design necessitating frequent bending and twisting and generally the way work is organized. As expected, the high number of hand/wrist observed in the miners could be as a result of handling techniques employed in the mining process. It is also very clear in this study that working very fast, insufficient time to do work as well as the level of training are significantly associated with the development of WMSIs.

Finally, as suggested by the majority of mine workers in this study, it is likely that work over load due to insufficient workforce, and poor maintenance of machinery will lead to greater stress and morbidity in mine workers if left unattended.

6.4 RECOMMENDATIONS

Based on the findings of this study, the following recommendations are suggested.

1. Further research into risk factors is required, especially on the effect of age, experience and occupation on injury occurrence.
2. Future studies that address possible recall bias and consider exposure time should be conducted.
3. The results of this study can be used to assist with policy development in the mines
4. Promotional education on primary prevention among underground mine workers is required and must include increasing worker awareness of risk factors associated with WMSIs.
5. Tasks with the highest risks for injury should be established and participatory approaches to risk assessment and management employed.
6. The capacity of the Mine Safety Department should be strengthened to ensure regular inspection of the mines for hazards.



6.5 LIMITATIONS OF THE STUDY

1. Injuries were self-reported and therefore obtaining the accurate information is not possible
2. Recall over 12 months may lead to reliability compromise (Recall bias)
3. The nature of the work at underground mines (shifts) which affected the response rate (202 mine workers out of 500). It was very difficult to find all workers at the mine during the collection of questionnaires
4. Change of data collection procedure: the researcher had initially intended to gather data via interviews in order to maximize the response rate but self administered was used instead due to circumstances beyond the researcher's control.

References

Ariens, G.A.M., Van Mechelen, W., Bongers, P.M., Bouter, L.M., & Van Derwal, G. (2000). Physical risk factors for neck pain. *Scandinavian Journal of Work Environment and Health*, 26(1), 7-19.

Babbie, E., & Mouton, J. (2006). The practice of social research. Cape Town, South Africa: Oxford University press.

Bartlett, E.J., Kotrlik, W.J., & Higgins, C.C. (2001). Organizational research: Determining appropriate sample size in survey research. *Information Technology, Learning, and Performing Journal*, 19(1), 43-50.

Barret, H.J., Haslam, R.A., Lee, K.G., & Ellis, M.J. (2005). Assessing attitude and belief using the state of change paradigm-case study of health and safety appraisal within a manufacturing company. *International Journal of Industrial Ergonomics*, 35, 871-887.

Bio, F.Y., Sadhra, S., Jackson, C., & Burge, P.S. (2007). Low back pain in underground gold miners in Ghana. *Ghana Medical Journal*, 41(1), 21-25.

Bongers, P.M., De Winter, C.R., Kompier, M.A.J., & Hildebrandt, V.H. (1993). Psychosocial factors at work and musculoskeletal disease. *Scandinavian Journal of Work, Environment and Health*, 19(5), 297-312.

Buckle, P.W., & Devereux, J.J. (2002). The nature of work-related neck and upper limb musculoskeletal disorders. *Applied Ergonomics*, 33, 207-217.

Burgess-limerick, R., Straker, L., Pollock, C., Dennis, G., Leveritt, S., & Johnson, S. (2007). Implementation of the participative ergonomics for manual tasks (PErforM) programme at four Australian underground coal mines. *International Journal of Industrial Ergonomics*, 37, 145-155.

Chi, C., Chang, T., & Hung, K. (2004). Significant industry source of injury-accident type for occupational fatalities in Taiwan. *International Journal of Industrial Ergonomics*, 34, 74-91.



Coleman, P.J., & Kerkering, J.C. (2007). Measuring mining safety with injury statistics: Lost workdays as indicators of risk. *Journal of Safety Research*, 38, 523-533.

Craig, J. (2002). Twilight on the Zambian Copperbelt? The African Diaspora and Development, *Review of African Political Economy*, 29(92), 364-368.

Dembe, A.E., Erickson, J.B., Delbos, R.G., & Banks, S.M. (2005). The impact of overtime and long work hours on occupational injuries and illnesses: new evidence from the United States. *Occupational Environmental Medicine*, 62, 588-597.

De Vos, A.S. (2nd ed) (2002). Research at Grass Roots, for the social sciences and human service professions. Pretoria: Van Schaik Publishers.

Dias, B., & Shutte, P.C. (2005). Work-related musculoskeletal Disorders in the South African mining industry. Occupational Health and Safety; Retrieved 28 March, 2007, from <http://www.saioh.org/ioha2005/proceedings/papers/SSK1>

Donoghue, A.M. (2004). Occupational health hazards in mining: An overview. *Occupational Medicine*, 54, 283-289.

Du plessis, S., & Du plessis, S. (2006). Explanations for Zambia's economic decline. *Development Southern Africa*, 23(3), 351- 369.



Edelman, C. L. & Mandle, C.L. (1998). Health promotion throughout the lifespan, Environment-dependent factors. USA. Mosby. P205.

Fabiano, B., Curro, F., Reverberi, A.P., & Pastorino, R. (2008). A statistical study on temporal work and occupational accidents: specific risk factors and risk management strategies. *Safety Science*, 46, 535-544.

Furlow, B. (2002). Ergonomics in the health care environment. *The Journal of Radiologic Technology*, 74 (2): 137-153.

Franco, G., & Fusetti, L. (2004). Bernardino Ramazzini's early observations of the link between musculoskeletal disorders and ergonomic factors. *Applied Ergonomics*, 35, 67-70.

Friedrich, M., Cermak, T., & Heiller, I. (2000). Spinal troubles in sewerage workers. Epidemiological data and work disability due to low back pain. *International Archive of Occupational Environmental Health*, 73, 245-254.

Galizzi, M., & Zagorsky, J.L. (2008). How do on-the-job injuries and illnesses impact wealth? Retrieved 23 July, 2008 from <http://www.sciencedirect.com/science>

Garenne, M., & Gakusi, A.E. (2006). Vulnerability and resilience: Determinants of under-five mortality changes in Zambia. *World Development*, 34(10), 1765-1787.

Ghosh, A. K., Bhattacharjee, A., & Chau, N. (2004). Relationships of working conditions and characteristics to occupational injuries: A case-control study in coal miners. *Journal of Occupational Health*, 46, 470-478.

Groves, W.A., Kecojevic, V.J., & Komljenovic, D. (2007). Analysis of fatalities and injuries involving mining equipment. *Journal of Safety Research*, 38, 461-470.

Guide to the Mining Regulations (1973). Retrieved 15, January, 2008. From the Zambian Mine Safety Department, Kitwe Zambia.

Gyekye, S.A. (2003). Causal attributions of Ghanaian industrial workers for accident occurrence: Miners and non-miners perspective. *Journal of Safety Research*, 34, 533-538.

Hickman, J.S., & Geller, E.S. (2003). A safety self-management intervention for mining operations. *Journal of Safety Research*, 34, 299-308.

Hine, D.W., Lewko, J., & Blanco, J. (1999). Alignment to work place safety principles: an application to mining. *Journal of Safety Research*, 30(3), 173-185.

Hull, B.P., Leigh, J., Driscoll, T.R., & Mandryk, J. (1996). Factors associated with occupational injury severity in the New South Wales underground coal mining industries. *Safety Science*, 21, 191-204.

Jeong, B.Y. (1997). Occupational deaths and injuries in the construction industry. *Applied Ergonomics*, 29(5), 355-360.

Joyce, S. (1998). Major issues in miner health: *Environmental Health Perspective*, 106(11), 538-543.

Karra, V.K. (2005). Analysis of non-fatal and fatal injury rates for mine operators and contractor employees and the influence location. *Journal of Safety Research*, 36, 413-421.

Katz, E. N. (1995). The Underground Route to Mining: Afrikaners and the Witwatersrand Gold Mining Industry from 1902 to the 1907 Miners' Strike. *The Journal of African History*, 36(3), 467-489.

Komljenovic, D., Groves, W.A., & Kecojevic, V.J. (2007). Injuries in U.S. mining operations-a preliminary risk analysis. *Safety Science*, 46, 792-801.

Komljenovic, D., Groves, W.A., & Kecojevic, V.J. (2008). Injuries in U.S. mining operations-a preliminary risk analysis. *Safety Science*, 46, 792-801.



Kottner, J., & Dassen, T. (2008). An inter-rater reliability study of the braden scale in two nursing homes. *International Journal of Nursing studies*, 45, 1501-1511.

Kuorinka, I., Jonsson, B., & Kilbom A. (1987). Nordic questionnaire for the analysis of musculoskeletal symptoms. *Applied Ergonomics*, 18, 233 – 237.

Kowalski-Trakofler, K.M., & Barrett, E.A. (2003). The concept of degraded images applied to hazard recognition training in mining for reduction of lost-time injuries. *Journal of Safety Research*, 34, 515-525.

Laflamme, L., Menckel, E., & Lundholm, L. (1996). The age-related risk of occupational accidents: the case of Swedish iron ore miners. *Accident Analysis and Prevalence*, 28(3), 349-357.

Larsson, T.J., & Field, B.(2002). The distribution of occupational injury risks in the state of Victoria. *Safety Science*, 40, 419-437.

Le, C.T., & Boen, J.R. (1995). Health and numbers: Basic Biostatistics methods. *Journal of Clinical Nursing*, 9, 178-188.

Lee, H., Yeh, W., Chen, C., & Wang, J. (2005). The prevalence and psychosocial risk factors of upper extremity musculoskeletal pain in industries of Taiwan. A national wide study. *Journal of Occupational Health*, 47, 311-318.

Leigh, J., Macaskill, P., Kuosma, E., & Mandryk, J. (1999). Global burden of disease and injury due to occupational factors. *Epidemiology*, 10(5), 626-631.

Levin, K.A. (2006). Cross-sectional studies. *Evidence Based Dentistry*, 7, 24-25.

Lin, Y., Chen, C., & Luo, J. (2008). Gender and age distribution of occupational fatalities in Taiwan. *Accident Analysis and Prevention*, 1604-1610.

Linton, S.J., & Ryberg, M. (2000). Do epidemiological results replicate? the prevalence and health-economic consequences of neck and back pain in the general population. *European Journal of Pain*, 4, 347-354.

Loewenson, R. (n.d.). Occupational health and safety in southern Africa: Trends and policy issues. ILO/SAMAT Policy. Retrieved 21 June, 2007, from <http://www.asosh.org/SADC/sadcmmap.htm>

Loewenson, R. (2001). Globalization and occupational health: a perspective from South Africa. *Bulletin of the World Health Organization*, 79, 863-868.

Löfgren, H., Robinson, S., & Thurlow, J. (2002). Macro and micro effects of recent and potential shocks to copper mining in Zambia. International Food Policy Research Institute. Retrieved 20 July, 2008, from <http://www.cgiar.org/ifpri/divs/tmd/dp.htm>

MacFarlane, G.J., Hunt, I.M., & Silman, A.J. (2000). Role of mechanical and psychosocial factors in the onset of forearm pain: Prospective population based study. *British Medical Journal*, 321(7262), 676-679.

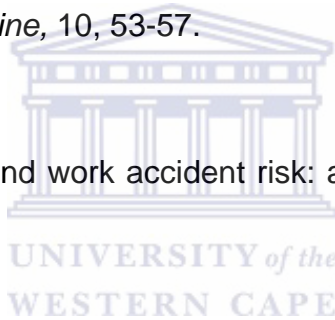
Maiti, J. (2003). Development of risk indices for underground coal mine workers in India. *Mining Technology*, 112, 119-124.

Maiti, J., & Bhattacharjee, A. (1999). Evaluation of risk of occupational injuries among underground coal mine workers through multinomial logit analysis. *Journal of Safety Research*, 30 (2), 93-101.

Maiti, J., Chatterjee, S., & Bangdiwala, S.I. (2004). Determinants of work injuries in mines: An application of structural equation modeling. *Injury Control and Safety Promotion*, 11(1), 29-37.

Mandal, B.B., & Srivastava, A.K. (2006). Risk from vibration in Indian mines. *Indian Journal of Environmental Medicine*, 10, 53-57.

Mainardi, S. (2005). Earnings and work accident risk: a panel data analysis on mining. *Resources Policy*, 30, 156-167.



Mallet, L., Peters, R.H., & Schwerha, D.J. (2006). What difference does age make? Part 3: metal ore mine injuries. Department of Labor, Mine Safety and Health Administration.

McMillan & Nichols. (2005). Osteoarthritis and meniscus disorders of the knee as occupational diseases of miners: *Occupational and Environmental Medicine*, 62(8), 567-575.

McPhee, B. (2004). Ergonomics in mining. *Occupational Medicine*, 54, 299-303.

Miller, B.H., Sinkala, T., Renger, F.R., Peacock, M.E., Tabor, A.J., & Burger, L.J. (2006). Identifying antecedent conditions responsible for the high rates of mining injuries in Zambia. *International Journal of Occupational Environmental Health*, 12, 329-339.

Miller, D., Desai, N., & Lee-Thorp, J. (2000). Indigenous Gold Mining in Southern Africa. *African Naissance*, 8, 91-99.

Miller, (1995). Injuries to workers and their dependants. *Journal of Safety Research*, 26(2), 75-85.

Moller, G.P., & Rothmann, S. (2006). The implementation and evaluation of a behavior-based safety intervention at an iron ore mine. *Sajems NS*, 9 (3), 299-314.

Mirmohamadi, M., Seraji, J.N., Shahtaheri, J., Lahmi, M., & Ghasemkhani, M. (2004). Evaluation of risk factors causing musculoskeletal disorders using QEC method in a furniture producing unit. *Iran Journal of Public Health*, 33(2), 24-27.

Mitchell, R.S., Driscoll, T.R., & Harrison, H.E. (1998). Traumatic work-related fatalities involving mining in Australia. *Safety Science*, 29, 107-123.

Moore, S.M., Bael, E.R., & Steiner, L.J. (2007). Prevalence and cost of cumulative injuries over two decades of technological advances: A look at underground coal mining

in the U.S. SME Annual meeting and exhibit, February 25-28, Colorado, Littleton, Co: Society for mining, metallurgy, and exploration, Inc., Feb.; 1-4.

O'Reilly, S.C., Miur. K.R., & Doherty, M. (2000). Occupation and Knee pain: A community study. *Osteoarthritis Cartilage Journal*, 8(2), 78-81.

Ostensvik, T., Veiersted, K. B., Cruchet, E., Nilsen, P., Hanse, J.J., Carlzon, C., & Winkel, J. (2008). A search for risk factors of upper extremity disorders among forest machine operators: A comparison between France and Norway. *International Journal of Industrial Ergonomics*, 38, 1017-1027.

Palmer, K., Smith, G., Kellingray, S., & Cooper, C. (1999). Repeatability and validity of an upper limb and neck discomfort questionnaire: the utility of the standardized Nordic questionnaire. *Occupational Medicine*, 49 (3), 171-175.

Patel, H., Ekman, I., Spertus, J.A., Wasserman, S.M., & Persson, L. (2008). Psychometric properties of a Swedish version of the Kansas City Cardiomyopathy Questionnaire in a Chronic Heart Failure population. *European Journal of Cardiovascular Nursing*, 7, 214–221.

Paul, P.S., Maiti, J., Dasgupta, S., & Forjough, S.N. (2005). An Epidemiological study of injury in mines: Implication for safety promotion. *International Journal of Injury Control and Safety Promotion*, 12(3), 157-165.

Paul, P.S., & Maiti, J. (2007). The role of behavioral factors on safety management in underground mines. *Safety Science*, 45, 449-471.

Punnet, L., & Wegman, H.D. (2004). Work-related musculoskeletal disorders: The epidemiologic evidence and debate. *Journal of Electromyography and Kinesiology*, 14, 13-23.

Radford, B. (2000). Too much sitting can cause back pain. *The Gazette*, Retrieved 22 August, 2007, from <http://www.gazette.com>

Rosecrance, J.C, & Cook, T.M. (1998). Upper extremity musculoskeletal disorders: Occupational association and a model for prevention. *Central European Journal of Occupational and Environmental Medicine*, 4(3), 214-231.

Safety and Health in Workplace is Critical. (2007, August 12). *Times of Zambia News Paper*. Retrieved, 24 June, 2008, from <http://allafrica.com/stories/200708130814.html>

Salminen, S. (2004) Have young workers more injuries than older ones? An international literature review, *Journal of Safety Research*, 35, 513-521.

Sari, M., Duzgun, H.S.B, Karpuz, C., & Selcuk, A.S. (2004). Accident analysis of two Turkish underground coal mines. *Safety Science*, 42, 675-690.

Strunin, L., & Boden, L.I. (2004). Family consequences of chronic back pain. *Social Science & Medicine*, 58, 1385-1393.

Torma-Krajewski, J. (2007a). Washington state risk factor checklist. National Institute for occupational health and safety/Pittsburgh research lab, Washington.

Torma-Krajewski, J. (2007b). Upper limb Core QX checklist. National Institute for occupational health and safety/Pittsburgh research lab, Washington.

Torma-Krajewski, J., Hipes, C., Steiner, L., & Burgess-Limerick, R. (2007). Ergonomic interventions at Vulcan Materials Company: 1-4. Retrieved May 15, 2007, from <http://www.cdc.gov/niosh/mining/pubs/pubreference/outputid2297.htm>

Torma-Krajewski, J., Steiner, L., Lewis, P., Gust, P., & Johnson, K. (2007). Implementation of an ergonomics process at a US Surface coal mine. *International Journal of Industrial Ergonomics*, 37, 157-167.

UN, International Human Rights Instruments. (2005). Central statistics Office, 2000 census of population and Housing, Lusaka, Zambia.

U.S. General Accounting office. (2003). Report to Congressional Requesters

Ural, S., & Demirkol, S. (2007). Evaluation of occupational safety and health in surface mines. *Safety Science*, 46, 1016-1024.

U.S. Bureau of labor statistics. (1991). Occupational injury and illnesses in the United States by industry, 1989, 237.

Vuuren, B.V., Zinzen, E., Heerden, H.J.V., Becker, P., & Meeusen, R. (2005). Psychosocial factors related to lower back problems in a South African manganese industry. *Journal of Occupational Rehabilitation*, 15(2), 1220-1221.

Watson, P.J., Booker, C.K., Moores, L., Main, C.J. (2004). Returning the chronically unemployed with low back pain to employment. *European Journal of Pain*, 8, 359-369.

Wells, R., Mathiassen, S.E., Medbo, L., & Winkel, J. (2007). Time-A key issue for musculoskeletal health and manufacturing. *Applied Ergonomics* 38, 733-744.

Wenig, C.M., Schmidt, C.O., Kohlmann, T., Schweikert, B. (2008). Costs of back pain in Germany. *European Journal of Pain*, (In press), retrieved 12 August, 2008 from <http://www.sciencedirect.com/science>

Wiehagen, W.J., & Turin, F.C. (2004). Ergonomic assessment of musculoskeletal risk Factors at four mine sites: Underground coal, surface copper, surface phosphate, and

underground limestone. Information circular 9475. Retrieved 21 March, 2007 from, <http://www.Cdc.Gov/niosh/mining/pubs/pdfs/2004-159>.

Wilder, D.G., Pope, M.H., & Magnusson, M. (1996). Mechanical stress reduction during seated jolt/vibration exposure. *Seminars in Perinatology*, 20(1), 54-60.

Wilson, A., & Boyling, J.D. (2002). Effective management of musculoskeletal injury. A clinical ergonomics approach to prevention, treatment and rehabilitation. United Kingdom, Harcourt publishers limited.

Winn, F.J., Biersner, R.J., Morrissey, S. (1996). Exposure probabilities to ergonomic hazards among miners. *International Journal of Industrial Ergonomics*, 18, 417-422.

Yilee, H., Yu Yeh, W., Wan Chen, C., & Derwang, J. (2005). The prevalence and psychosocial risk factors of upper extremity musculoskeletal pain in industries of Taiwan: A national wide study. *Journal of Occupational Health*, 47, 311-318.

APPENDICES



UNIVERSITY *of the*
WESTERN CAPE

Appendix B

13 December 2007

Mopani Copper Mines PLC
Administration and Training Manager
P.O. Box 22000,
Kitwe, Zambia

Re: Permission to conduct a research study

I am a Zambian postgraduate student enrolled in the Physiotherapy (Masters) programme at the University of the Western Cape, South Africa. I am expected to conduct a research study as part of the requirements for the course. The title of my study is “Prevalence of and risk factors for work-related musculoskeletal injuries amongst underground mine workers in Kitwe, Zambia”.

Please find the attached letters of acceptance of my research proposal by the authorities of the University of the Western Cape and the Ministry of Mines and Minerals Development. I here by request permission to conduct the above mentioned study at your company.

It is hoped that the results of this study in Zambia will contribute to information needed to design effective work-related injury prevention programmes in the mines through the identification of risk factors associated with work-related injuries.

I would be grateful if you could allow me to conduct the study from December 2007, to February 2008. Participation in this study will be anonymous and voluntary. The information collected will be treated with respect and confidentiality and the company's name will be withheld. All participants will be identified using codes and the information will be kept in a secure filing cabinet or safe so as to safeguard their anonymity and all the individuals directly or indirectly referred to in the questionnaire.

A positive and timely response will be highly appreciated.

Yours faithfully,

Richard Kunda

Supervisor: Professor José Frantz

Co-supervisor: Ms Farhana Karachi

Appendix D

10th January, 2008.

Ministry of Mines and Minerals Development

P.O. Box 31969,

Lusaka, Zambia.

Dear Sir/ Madam

Re: Permission to conduct a research study

I am a Zambian postgraduate student enrolled in the Physiotherapy (Masters) programme at the University of the Western Cape, South Africa. I am expected to conduct a research study as part of the course. The title of my study is “Prevalence of and risk factors for work-related musculoskeletal injuries amongst underground mine workers in Kitwe, Zambia”. Please find the attached letter of acceptance of my research proposal by the authorities of the University of the Western Cape-South Africa. I hereby request permission to gather data at the Mines Safety Department on Mopani underground copper mines in Kitwe. It is hoped that the results of this study in Zambia will contribute to information needed to design effective work-related injury prevention programmes in the mines through the identification of risk factors associated with work-related injuries in the mines. The information collected will be treated with respect and confidentiality and will be kept in a secure filing cabinet or safe so as to safeguard anonymity.

A positive and timely response will be highly appreciated

Yours faithfully,

Richard Kunda

Supervisor: Professor José Frantz

Co-supervisor: Ms Farhana Karachi

Appendix F



UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa

Tel: +27 21-959, Fax: 27 21-959

E-mail:

INFORMATION SHEET

Dear respondent,

I am a postgraduate student doing a Master of Science degree in the Department of physiotherapy at the University of the Western Cape. As part of the course, am expected to conduct a research study. The title of my research is "Prevalence of and risk factors for Work-related musculoskeletal injuries amongst underground mine workers in Kitwe, Zambia." Information gathered in this study will be important to plan holistic physiotherapy rehabilitation, and health promotion programs for you and other mine workers in the country.

If you agree to participate in this study I will consult with you to arrange a suitable time and day for collection of the relevant information. Participation in the study will involve filling in a questionnaire that will take at least 30 minutes. The information you give will be treated with the utmost respect and confidentiality.

This provides you with an opportunity to appreciate and contribute to scientific research that may provide information about prevalence of and risk factors associated to mining that could be useful to the government, physiotherapists, and other health promoters.

There is no risk to you for participating in this study, and it is expected that you will experience minimal discomfort or stress from the questions asked in the questionnaire. You don't have to respond to every question or provide information you do not want to provide and can withdraw from participating at any time.

Occasionally, a follow-up interview may be necessary to clarify some information. The researcher could request your participation.

All participants will be identified using codes and the information will be kept in a secure filing cabinet or safe so as to safeguard their anonymity and all the individuals directly or indirectly referred to in the questionnaire. In the future the researcher will destroy all code lists.

Appendix G

UNIVERSITY OF THE WESTERN CAPE



Private Bag X 17, Bellville 7535, South Africa

Tel: +27 21-959, Fax: 27 21-959

E-mail:

CONSENT FORM

Title of Research Project: Prevalence of and risk factors for Work-related musculoskeletal injuries amongst underground mine workers in Kitwe, Zambia

The study has been described to me in a language that I understand and I freely and voluntarily agree to participate. My questions about the study have been answered. I understand that my identity will not be disclosed and that I may withdraw from the study without giving a reason at any time and this will not negatively affect me in any way.

Participant's signature..... **Date:**

Should you have any questions regarding this study or wish to report any problems you have experienced related to the study, please contact the study coordinator:

Study Coordinator's Name: Richard Kunda

University of the Western Cape

Private Bag X17, Belville 7535

Cell: +27794334247

Email: 2730060@uwc.ac.za or princer1@gmail.com

Appendix H

Responding to the questionnaire

No. __

Date __/__/__

On the following pages are questions about your work and the organization where you work. The purpose of this questionnaire is to collect the information needed to identify risk factors for work-related injuries at your work place. It is also hoped that the information collected will help develop your work and the work environment. Please take your time answering. Answer all questions if you can by choosing the alternative that best describes your opinion. Be assured that the information you give shall be kept confidential and anonymous. Mark the choice that best applies to your situation with a ✓ or X

SECTION A DEMOGRAPHIC DATA




1. Sex: Male 1 Female 2 2. Weight _____ Kg 3. Height _____ M 4. Age _____ yrs
5. Highest level of education: Primary Secondary College University
7. Income per month: Less than K1 000 000 1 More than K1 000 000 2
8. Title of occupation:
- 9a. How long have you worked for this mine? _____ Years
- 9b. In what department/Section/Unit do you work?
10. How many years have you been doing your present kind of work?Years
11. Is your employment contract permanent Yes 1 No 2
12. Is your job a supervisory position? Yes 1 No 2
13. How many hours per shift do you work?





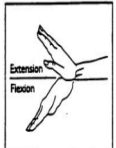

Section B: This part of the questionnaire is designed to determine the musculoskeletal (muscle + bone) symptoms among workers. Note that the questionnaire is to be answered even if you have never had trouble (ache, pain, numbness, injury) in any part of your body.

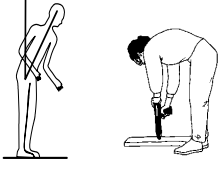

To be answered by everyone			To be answered by those who have had trouble			
1. Have you at anytime during the last 12months had trouble (ache, pain, numbness, injury) In:			2. Have you at anytime during the last 12months been prevented from doing your normal work (at home or away from home) because of the trouble?		3. Have you had trouble at anytime during the last 7 days?	
a. Neck	<input type="checkbox"/>	1. No 2. Yes	<input type="checkbox"/>	1. No 2. Yes	<input type="checkbox"/>	1. No 2. Yes
b. Shoulder	<input type="checkbox"/>	1. No	<input type="checkbox"/>	1. No	<input type="checkbox"/>	1. No
	<input type="checkbox"/>	2. Yes, right shoulder	<input type="checkbox"/>	2. Yes	<input type="checkbox"/>	2. Yes
	<input type="checkbox"/>	3. Yes, left shoulder				
	<input type="checkbox"/>	4. Yes, both shoulders				
c. Elbows	<input type="checkbox"/>	1. No	<input type="checkbox"/>	1. No	<input type="checkbox"/>	1. No
	<input type="checkbox"/>	2. Yes, right elbow	<input type="checkbox"/>	2. Yes	<input type="checkbox"/>	2. Yes
	<input type="checkbox"/>	3. Yes, left elbow				
	<input type="checkbox"/>	4. Yes, both elbows				
d. Wrists/Hands	<input type="checkbox"/>	1. No	<input type="checkbox"/>	1. No	<input type="checkbox"/>	1. No
	<input type="checkbox"/>	2. Yes, right wrist/hand	<input type="checkbox"/>	2. Yes	<input type="checkbox"/>	
	<input type="checkbox"/>	3. Yes, left wrist/hand				
	<input type="checkbox"/>	4. Yes, both wrists/hand				
e. Upper back	<input type="checkbox"/>	1. No	<input type="checkbox"/>	1. No	<input type="checkbox"/>	1. No
	<input type="checkbox"/>	2. Yes	<input type="checkbox"/>	2. Yes	<input type="checkbox"/>	2. Yes
f. Lower back	<input type="checkbox"/>	1. No	<input type="checkbox"/>	1. No	<input type="checkbox"/>	1. No
	<input type="checkbox"/>	2. Yes	<input type="checkbox"/>	2. Yes	<input type="checkbox"/>	2. Yes
g. One or both hips/thighs	<input type="checkbox"/>	1. No	<input type="checkbox"/>	1. No	<input type="checkbox"/>	1. No
	<input type="checkbox"/>	2. Yes	<input type="checkbox"/>	2. Yes	<input type="checkbox"/>	2. Yes
h. One or both knees	<input type="checkbox"/>	1. No	<input type="checkbox"/>	1. No	<input type="checkbox"/>	1. No
	<input type="checkbox"/>	2. Yes	<input type="checkbox"/>	2. Yes	<input type="checkbox"/>	2. Yes
i. One or both ankles/feet	<input type="checkbox"/>	1. No	<input type="checkbox"/>	1. No	<input type="checkbox"/>	1. No
	<input type="checkbox"/>	2. Yes	<input type="checkbox"/>	2. Yes	<input type="checkbox"/>	2. Yes

- Based on the Nordic questionnaire

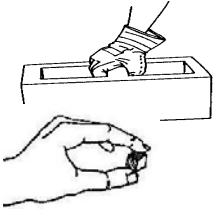
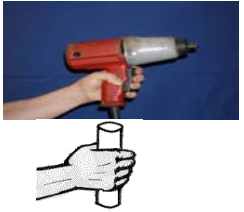
Section C: This part of the questionnaire will measure the physical aspects of your work. Mark the choice that best applies to your job with a ✓ or X.

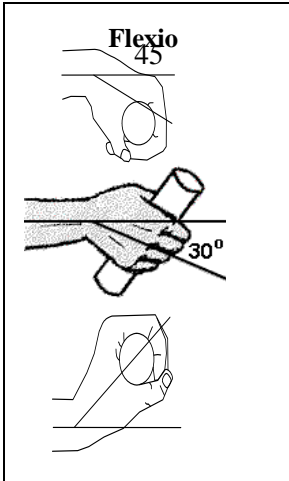
1. Heavy or Frequent Lifting / Lowering / Shoveling																					
 	<p>a. Do you lift <u>or</u> lower objects weighing more than 50Kgs?</p> <table border="1"> <tr> <td>Never</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td>Occasionally</td> <td><input type="checkbox"/></td> </tr> <tr> <td>Less than 10 times per day</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td>More than 10 times per day</td> <td><input type="checkbox"/></td> </tr> </table> <p>b. Do you lift <u>or</u> lower objects weighing more than 25kgs?</p> <table border="1"> <tr> <td>Never</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td>Occasionally</td> <td><input type="checkbox"/></td> </tr> <tr> <td>Less than 10 times per day</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td>More than 10 times per day</td> <td><input type="checkbox"/></td> </tr> </table>	Never	<input type="checkbox"/>	<input type="checkbox"/>	Occasionally	<input type="checkbox"/>	Less than 10 times per day	<input type="checkbox"/>	<input type="checkbox"/>	More than 10 times per day	<input type="checkbox"/>	Never	<input type="checkbox"/>	<input type="checkbox"/>	Occasionally	<input type="checkbox"/>	Less than 10 times per day	<input type="checkbox"/>	<input type="checkbox"/>	More than 10 times per day	<input type="checkbox"/>
Never	<input type="checkbox"/>	<input type="checkbox"/>	Occasionally	<input type="checkbox"/>																	
Less than 10 times per day	<input type="checkbox"/>	<input type="checkbox"/>	More than 10 times per day	<input type="checkbox"/>																	
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	<p>c. Do you do a lot of Shoveling?</p> <table border="1"> <tr> <td>Never</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td>Occasionally</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>Less than 2 hrs per day</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td>2 - 4hrs per day</td> <td><input type="checkbox"/></td> <td>More than 4hrs per day</td> </tr> </table>	Never	<input type="checkbox"/>	<input type="checkbox"/>	Occasionally	<input type="checkbox"/>	<input type="checkbox"/>	Less than 2 hrs per day	<input type="checkbox"/>	<input type="checkbox"/>	2 - 4hrs per day	<input type="checkbox"/>	More than 4hrs per day								
Never	<input type="checkbox"/>	<input type="checkbox"/>	Occasionally	<input type="checkbox"/>	<input type="checkbox"/>																
Less than 2 hrs per day	<input type="checkbox"/>	<input type="checkbox"/>	2 - 4hrs per day	<input type="checkbox"/>	More than 4hrs per day																

2. Awkward Postures													
 	<p>a. Do you work with hand(s) above the head?</p> <table border="1"> <tr> <td>Never</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td>Occasionally</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>Less than 2 hrs</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td>2 - 4hrs</td> <td><input type="checkbox"/></td> <td>More than 4hrs</td> </tr> </table> <p style="text-align: right;">Total/day</p>	Never	<input type="checkbox"/>	<input type="checkbox"/>	Occasionally	<input type="checkbox"/>	<input type="checkbox"/>	Less than 2 hrs	<input type="checkbox"/>	<input type="checkbox"/>	2 - 4hrs	<input type="checkbox"/>	More than 4hrs
Never	<input type="checkbox"/>	<input type="checkbox"/>	Occasionally	<input type="checkbox"/>	<input type="checkbox"/>								
Less than 2 hrs	<input type="checkbox"/>	<input type="checkbox"/>	2 - 4hrs	<input type="checkbox"/>	More than 4hrs								
  <p>30°</p>	<p>b. Do you Work with the neck bent more than 30 degrees (without support)?</p> <table border="1"> <tr> <td>Never</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td>Occasionally</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>Less than 2 hrs</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td>2 - 4hrs</td> <td><input type="checkbox"/></td> <td>More than 4hrs</td> </tr> </table> <p style="text-align: right;">Total/day</p>	Never	<input type="checkbox"/>	<input type="checkbox"/>	Occasionally	<input type="checkbox"/>	<input type="checkbox"/>	Less than 2 hrs	<input type="checkbox"/>	<input type="checkbox"/>	2 - 4hrs	<input type="checkbox"/>	More than 4hrs
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Less than 2 hrs	<input type="checkbox"/>	<input type="checkbox"/>	2 - 4hrs	<input type="checkbox"/>	More than 4hrs								
  <p>30°</p>	<p>c. Do you work with a bent wrist(s)?</p> <table border="1"> <tr> <td>Never</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td>Occasionally</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>Less than 2 hrs</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td>2 - 4hrs</td> <td><input type="checkbox"/></td> <td>More than 4hrs</td> </tr> </table> <p style="text-align: right;">Total/day</p>	Never	<input type="checkbox"/>	<input type="checkbox"/>	Occasionally	<input type="checkbox"/>	<input type="checkbox"/>	Less than 2 hrs	<input type="checkbox"/>	<input type="checkbox"/>	2 - 4hrs	<input type="checkbox"/>	More than 4hrs
Never	<input type="checkbox"/>	<input type="checkbox"/>	Occasionally	<input type="checkbox"/>	<input type="checkbox"/>								
Less than 2 hrs	<input type="checkbox"/>	<input type="checkbox"/>	2 - 4hrs	<input type="checkbox"/>	More than 4hrs								

	<p>d. Do you work with the back bent (without support)?</p> <table border="1" data-bbox="373 262 1088 388"> <tr> <td>Never</td> <td></td> <td>Occasionally</td> <td></td> <td></td> </tr> <tr> <td>Less than 2 hrs</td> <td></td> <td>2 - 4hrs</td> <td></td> <td>More than 4hrs</td> </tr> </table> <p style="text-align: right;">Total/day</p>	Never		Occasionally			Less than 2 hrs		2 - 4hrs		More than 4hrs										
Never		Occasionally																			
Less than 2 hrs		2 - 4hrs		More than 4hrs																	
	<p>a. Does your job involve Squatting?</p> <table border="1" data-bbox="373 472 1088 598"> <tr> <td>Never</td> <td></td> <td>Occasionally</td> <td></td> <td></td> </tr> <tr> <td>Less than 2 hrs</td> <td></td> <td>2 - 4hrs</td> <td></td> <td>More than 4hrs</td> </tr> </table> <p style="text-align: right;">Total per day</p> <p>b. Does your job involve Kneeling?</p> <table border="1" data-bbox="373 682 1088 808"> <tr> <td>Never</td> <td></td> <td>Occasionally</td> <td></td> <td></td> </tr> <tr> <td>Less than 2 hrs</td> <td></td> <td>2 - 4hrs</td> <td></td> <td>More than 4hrs</td> </tr> </table> <p style="text-align: right;">Total/day</p>	Never		Occasionally			Less than 2 hrs		2 - 4hrs		More than 4hrs	Never		Occasionally			Less than 2 hrs		2 - 4hrs		More than 4hrs
Never		Occasionally																			
Less than 2 hrs		2 - 4hrs		More than 4hrs																	
Never		Occasionally																			
Less than 2 hrs		2 - 4hrs		More than 4hrs																	

3. High Hand Force - Pinch and power Grip

	<p>a. Do you Pinch unsupported objects?</p> <table border="1" data-bbox="373 1039 1161 1165"> <tr> <td>Never</td> <td></td> <td>Occasionally</td> <td></td> <td></td> </tr> <tr> <td>Less than 2 hrs</td> <td></td> <td>2 - 4hrs</td> <td></td> <td>More than 4hrs</td> </tr> </table> <p style="text-align: right;">Total per day</p> <p>b. what objects do you pick up with a pinch grip?</p>	Never		Occasionally			Less than 2 hrs		2 - 4hrs		More than 4hrs
Never		Occasionally									
Less than 2 hrs		2 - 4hrs		More than 4hrs							
	<p>b. Do you grasp an unsupported object(s) weighing 5 or more Kg per hand, or grasping with a forceful grip?</p> <table border="1" data-bbox="373 1354 1161 1480"> <tr> <td>Never</td> <td></td> <td>Occasionally</td> <td></td> <td></td> </tr> <tr> <td>Less than 2 hrs</td> <td></td> <td>2 - 4hrs</td> <td></td> <td>More than 4hrs</td> </tr> </table> <p style="text-align: right;">Total per day</p>	Never		Occasionally			Less than 2 hrs		2 - 4hrs		More than 4hrs
Never		Occasionally									
Less than 2 hrs		2 - 4hrs		More than 4hrs							



c. Does your job involve grasping objects with wrists bent?

Never		Occasionally		
Less than 2 hrs		2 - 4hrs		More than 4hrs

Total per day

4. Highly Repetitive Work



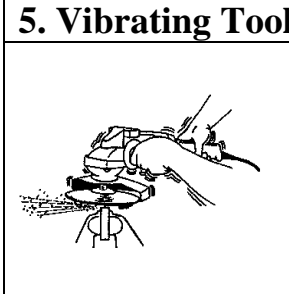
a. Does your work involve repeating the same motion with little or no variation every few seconds?

Never		Occasionally		
Less than 2 hrs		2 - 4hrs		More than 4hrs

Total per day



5. Vibrating Tools (Hand-Arm Vibration)



a. Does your work involve using grinders, jig saws or other hand tools that typically have moderate vibration levels?

Never		Occasionally		
Less than 2 hrs		2 - 4hrs		More than 4hrs

Total per day



b. Does your work involve using impact wrenches, chain saws, percussive tools (jack hammers, scalars, chipping hammers) or other tools that typically have high vibration levels?

Never			Occasionally		
Less than 30 minutes			More than 30minutes		

Total per day

6. Bouncing or Jarring (Whole Body Vibration)



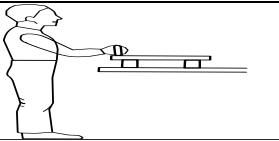
a. Does your work involve operating mobile equipment?

Never			Occasionally		
Less than 2 hrs			2 - 4hrs		More than 4hrs

b. Name Equipment _____

c. I travel over rough roads (circle one)

Never 1 Sometimes 2 Most of the time. 3. All the time. 4.



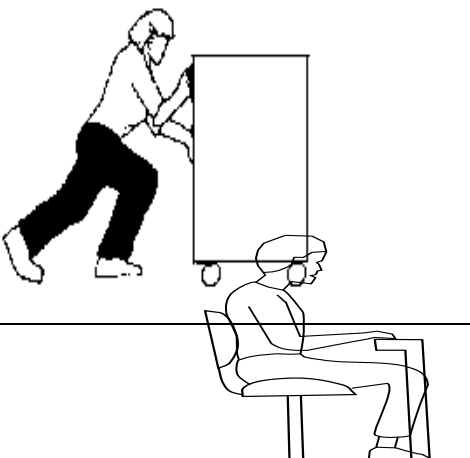
a. Does your work involve Standing without changing position?

Never			Occasionally		
Less than 2 hrs			2 - 4hrs		More than 4hrs

b. Does your work involve Sitting without changing position?

Never			Occasionally		
Less than 2 hrs			2 - 4hrs		More than 4hrs

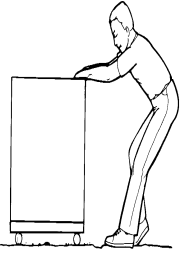
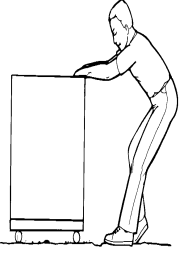
8. Pushing and Pulling



Does your work involve pushing against an object, such as a trolley with a **maximum effort** (body leaning with bent legs into the push)?

Never			Occasionally		
Less than 8 times			8-30times		More than 30times

Does your work involve pushing against objects, like a trolley with a **moderate effort** (body slightly leaning with straight legs into the push).

	<table border="1"> <tr> <td>Never</td> <td></td> <td>Occasionally</td> <td></td> <td></td> </tr> <tr> <td>Less than 16times</td> <td></td> <td>16-50times</td> <td></td> <td>More than 50times</td> </tr> </table>	Never		Occasionally			Less than 16times		16-50times		More than 50times
Never		Occasionally									
Less than 16times		16-50times		More than 50times							
	<p>Does your work involve pulling against objects, like a/an electrical cable, fuel hose or trolley with a <i>maximum effort</i> (body leaning with bent legs into the pull)?</p> <table border="1"> <tr> <td>Never</td> <td></td> <td>Occasionally</td> <td></td> <td></td> </tr> <tr> <td>Less than 8 times</td> <td></td> <td>8-30times</td> <td></td> <td>More than 30times</td> </tr> </table>	Never		Occasionally			Less than 8 times		8-30times		More than 30times
Never		Occasionally									
Less than 8 times		8-30times		More than 30times							
	<p>Does your work involve pulling against an object, such as a/an electrical cable, fuel hose, or trolley with a <i>moderate effort</i> (body slightly leaning with straight legs into the pull).</p> <table border="1"> <tr> <td>Never</td> <td></td> <td>Occasionally</td> <td></td> <td></td> </tr> <tr> <td>Less than 16times</td> <td></td> <td>16-50times</td> <td></td> <td>More than 50times</td> </tr> </table>	Never		Occasionally			Less than 16times		16-50times		More than 50times
Never		Occasionally									
Less than 16times		16-50times		More than 50times							

11. What improvements would you like to see for this job so as to make your work easier and safer?

Section D: This part of the questionnaire will measure the psychosocial aspect of your work. Please choose only one answer for each statement. Circle the choice that best describes your opinion as shown below.

For example:

How much do you agree or disagree with this statement?	Strongly disagree	Disagree	Agree	Strongly agree
I have a lot of say about what happens on my job	1	2	3	4

JOB DEMANDS

1. How much do you agree or disagree with these statements?	Strongly disagree	Disagree	Agree	Strongly agree
a. My job requires working very fast	1	2	3	4
b. My job requires working very hard	1	2	3	4
c. I am NOT asked to do an excessive amount of work	1	2	3	4
d. I have enough time to get the job done	1	2	3	4
e. My job requires that I learn new things	1	2	3	4
j. I am able to influence the availability of equipment needed to do my work.	1	2	3	4
k. I can take a break when I want to	1	2	3	4

JOB SATISFACTION AND SECURITY

2. How much do you agree or disagree with these statements?	Strongly disagree	Disagree	Agree	Strongly agree
a. My supervisor is willing to listen to my work-related problems.	1	2	3	4
b. I have job security	1	2	3	4
e. My job requires a great deal of concentration	1	2	3	4
i. In my job, there is constant pressure from my work group to keep up	1	2	3	4
j. My employer cares about my health and safety on the job	1	2	3	4
k. I receive the training I need to do my job well.	1	2	3	4

JOB CONTROL

3. How little or how much influence or control do you have over aspects of your work?

How much influence do you have over	Very little	Little	Moderate amounts	Much	Very Much
a. The variety of tasks you perform?	1	2	3	4	5
b. The amount of work you do?	1	2	3	4	5
c. The pace of your work, that is how fast or slow you work?	1	2	3	4	5
d. The hours that you work?	1	2	3	4	5

WORK RELATIONSHIPS

4. How much support do you receive on your job?	Very much or (very easy)	Much or (easy)	A little	Not at all
a. How much can your immediate supervisor be relied upon when things get tough at work?	1	2	3	4
b. How easy is it to talk with your immediate supervisor (boss)?	1	2	3	4
c. How much can your co-workers be relied upon when things get tough at work?	1	2	3	4
d. How easy is it to talk with your co-workers	1	2	3	4

MENTAL STATE (SELF EVALUATION)

5. How have you felt in the past month including today?

	Rarely or none of the time	Sometimes	Often	Most or all of the time
During the past month:				
a. I felt that everything I did was an effort	1	2	3	4
b. I was happy.	1	2	3	4
c. I felt depressed.	1	2	3	4

d. People were unfriendly.	1	2	3	4
e. I felt nervous.	1	2	3	4

THANK YOU VERY MUCH!

TWATOTELA MUKWAI!

