**SCHOOL OF PUBLIC HEALTH**

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# RISK FACTORS ASSOCIATED WITH WORK-RELATED MUSCULOSKELETAL SYMPTOMS AMONG MINERS AT GOLDFIELDS GHANA LIMITED, TARKWA MINES

**BY**

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# DECLARATION

I hereby declare that excluding precise references which have been duly acknowledged, this submission is my own work towards my MSC Occupational Hygiene dissertation and that, to the best of my knowledge, it contains no material previously submitted by another person nor material which has been accepted for the award of any other degree of the University or elsewhere.

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## DEDICATION

I dedicate this work to Mr. Divine Abodakpi and my family for their love, motivation, support and encouragement in all endeavours.

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# ABSTRACT

**Background:** Musculoskeletal disorders are common in most industries worldwide and result in in for example absenteeism, reduction in work output and productivity. Work in the mining sector involves exposure to several hazards. Although, most studies have focused on other occupational diseases, not much has been done in Ghana concerning work-related musculoskeletal symptoms (WMSS) among miners.

**Objective:** To assess the risk factors associated with work related musculoskeletal symptoms among miners of Goldfields Ghana Limited, Tarkwa.

**Methods:** The study adopted a cross-sectional study design using a Cornell musculoskeletal discomfort questionnaire and job content questionnaire among 180 randomly selected mineworkers. The data were analyzed with STATA (version 15). Bivariate analysis using Chi-square was performed to test the associations between independent variables and development of musculoskeletal symptoms. Multiple logistic regression analysis was carried out on all related factors, crude odds ratio (cOR) and adjusted odds ratio (AOR) were computed and statistical significance was set at $p < 0.05$.

**Results**: **Results**: The results of this study shows the overall proportion of miners that experienced work-related musculoskeletal symptoms of Goldfields Ghana Limited was 13.9% (95% CI: 8.7%-18.9%). The forearm [94.4% (95% CI: 91.1-97.8%], upper arm [69.4% (95% CI: 59.5-72.4%], and lower back [52.8% (95% CI: 39.8-54.6%], were the body parts with high prevalence of work-related musculoskeletal symptoms. Factors found to be significantly associated with the WMSS of the forearm were; type of department (AOR= 5.87; 95% CI=1.74-9.74), working category (AOR=0.25; 95% CI= 0.36-0.81) and job demand (AOR= 6.4; 95% CI=4.63-9.76). Number of times lifting objects weighing >25kg daily (AOR=1.28; 95% CI= 1.11-2.67), operate machines that cause whole body

vibrations AOR= AOR= 1.72; 95% CI=1.24-5.72) were associated with WMSS of lower back whilst the number of times lifting objects weighing >25kg daily (AOR=1.78; 95% CI= 1.36-5.67) and BMI (AOR= 2.27; 95% CI=1.35-5.03) were the factors found to be significant associated with WMSS of the upper arm.

**Conclusion**: The studies have found that the proportion of work-related musculoskeletal symptoms among miners of Goldfields Ghana Limited is very low. Job support should be given to the workers to improve their general well-being. These findings suggest the need for further research on the challenges work-related musculoskeletal symptom poses on productivity of the workers and the company at large.

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# LIST OF ABBREVIATIONS

| | |
|---|---|
| **BMI** | Body Mass Index |
| **CTD** | Cumulative Traumatic Disorders |
| **DHHS** | Department of Health and Human Services |
| **EU** | European Union |
| **GFL** | Goldfields Limited |
| **GGL** | Goldfields Ghana Limited |
| **ILO** | International Labour Organization |
| **ISO** | International Standardization Organization |
| **LBP** | Low Back Pain |
| **MSD** | Musculoskeletal Disorders |
| **NICE** | National Institute for Health and Care Excellence |
| **OOS** | Occupational Overuse Syndrome |
| **PPE** | Personal Protective Equipment |
| **RSI** | Repetitive Strain Injuries |
| **UKHSE** | United Kingdom Health, Safety and Environment |
| **WBV** | Whole-Body Vibration |
| **WHO** | World Health Organization |
| **WMSD** | Work-Related Musculoskeletal Disorders |
| **WMSS** | Work-Related Musculoskeletal Disorder Symptoms |

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background of the study

Mining has long been a valuable contributor to the economy in many countries especially in developing ones like Ghana. Formerly known as the Gold Coast, Ghana has mining activities run by multi-national companies which contribute immensely to the country's economy (Calys-Tagoe, Ovadje, Clarke, Basu, & Robins, 2015).

Mining has been characterized as one of the most hazardous occupations among major industrial activities by most researchers (Kunda, 2008; Omidi et al., 2017). The mining sector is associated with greater injury rates than other sectors and mine employees are often subjected to a higher danger of work-related musculoskeletal disorders (WMSD) (Cheng et. al., 2013). This could be due to the nature of the mining process. Mining involves drilling, blasting and charging to be able to access and retrieve the ore. Due to its labour intensive nature, most workers are at risk of developing WMSDs (Kibria, 2010).

According to a survey by the World Health Organization (WHO) in 2013, with respect to occupational health diseases, musculoskeletal disorders accounted for 48% of the total diseases caused by work. There are several factors categorized as physical, psychosocial, organizational and individual factors responsible for these disorders (Omidi et al., 2017).

Work related musculoskeletal disorders (WMSDs) refer to non-traumatic inflammatory or degenerative disorders of the musculoskeletal structures of the neck, back, shoulders, elbows, forearms, upper or lower extremities that develop over time, as a result of cumulative micro-trauma from biomechanical exposures such as repetitive motion, strenuous efforts, extreme joint postures and psychological factors (Korhan & Ahmed Memon, 2019).

In the United States, WMSDs, account for 65% of all occupational diseases. In the European Union (EU) countries, 39% of all occupational diseases are WMSDs (Widanarko et. al., 2014).

Most mining companies in developing countries such as Ghana do not have data regarding the prevalence of WMSDs. The study seeks to examine risk factors that are associated with work-related musculoskeletal symptoms (WMSS) among miners in Tarkwa mines.

## 1.2 Statement of the problem

Even though, modern mining involves the use of machines and equipment, work-related injuries cannot be exempted from the practices of mining (Tawiah, Oppong-Yeboah, & Bello, 2015). Mining, in general, involves difficult, physical work requiring the use of heavy machinery, awkward positions, and repetitive motions that can lead to work-related musculoskeletal symptoms (Shumate et al., 2017). Globally, musculoskeletal pain is the leading cause of disability *(*Ahenkorah *et al.*, 2019). According to the WHO, 800,000 Disability Adjusted Life Years are lost because of musculoskeletal pain problems in the world (WHO, Report 2002).

An increasing number of employees have been reporting with musculoskeletal symptoms such as neck, shoulder and low back pain in the Tarkwa Hospital in recent times for which reason a Pain clinic was established. In the Goldfields Well-being Report for 2017-2018, the total number of cases that reported and were diagnosed with musculoskeletal disorders was 205 workers. Out of these 205 workers, 78 (34.5%) were from the Heavy Mining Equipment (HME) department and 66 workers (31.7%) from the Mining department. The remaining 61 workers (29.6%) were from other departments (Engineering, Finance, Health and Safety, ICT, Metallurgy and Human Resource (Goldfields Ghana Well-being Report, 2018).

During mining operation, miners adopt diverse awkward postures such as frequent back twisting and bending that may result in severe low back pain. Working above shoulder heights, another common feature of mine work, may lead to upper back pain. Twisting of the neck may lead to neck pain. These symptoms adversely affect the work of miners leading to low productivity as a result of lost time injuries (Ahmad & Alvi, 2017; Tawiah et. al., 2015). Again, complications associated with WMSD are absenteeism, early retirement, and sickness. Considering the adverse effects associated with WMSD, it is imperative to study factors that may influence the risk of developing WMSD.

In addition, there is inadequate information regarding work-related musculoskeletal symptoms of mineworkers in Ghana and this prompted the researcher to undertake study.

## 1.3 General objective

To assess the prevalence and risk factors of Work-related musculoskeletal symptoms among miners of Goldfields Ghana Limited (Tarkwa Mines).

### 1.3.1 Specific objectives

1. To determine the proportion of work-related musculoskeletal symptoms among mine workers
2. To describe the body part mostly affected by work-related musculoskeletal symptoms.
3. To determine the risk factors associated with work-related musculoskeletal symptoms among the workers.

## 1.4 Justification

Surface mining is used to excavate ore out of the earth's surface and it includes open pit mining and dredging. This is the type of mining performed by Goldfields (Kibria, 2010).

Research investigating the prevalence and risk factors associated with WMSD among Ghana's mine employees is scarce (Tawiah et al., 2015). The significance of this study is to obtain scientific knowledge on factors that could increase the risk of developing work related musculoskeletal syndrome. The results of this study will help physiotherapists, medical professionals, government and Mining industries plan specific measures on how to reduce the problem through the development of specific preventive education strategies and policies. This will result in a decrease in absenteeism rates from work. Recommendations for changes in ergonomics at the workplace could further reduce production losses arising from absenteeism.

### 1.5 Conceptual framework

The conceptual framework in Figure 1.1 presents risk factors associated with work-related musculoskeletal symptoms (WMSS). Musculoskeletal disorders are a widespread and increasing occupational health problem in the workplace. The causes of workplace MSD are usually multifactorial and broadly categorized as physical, organizational, psychosocial and individual factors. It usually occurs among workers who work using awkward postures, excessive force, repetitive movements and lifting of heavy objects (Carolina Barreto Moreira Couto et al., 2019). Organizational, physical, and psychosocial and individual factors are found to be associated with the risk of developing Work Related Musculoskeletal Symptoms

Organizational issues such as work situation, and type of department of a worker are believed to be associated with work-related musculoskeletal symptoms. Research found that workers on contract often work for more hours and are more likely to experience WMSS compared to those who are full time staff (Da et al., 2010).

Physical hazards are still an everyday occurrence and it is considered as one of the risk factors for work-related musculoskeletal disorders. Physical workload factors include manual material handling (lifting a weight with an upright trunk, holding, carrying, pulling and pushing). Awkward postures- for example trunk postures, kneeling, squatting, arms above shoulder level, lack of physical activity; sitting without effective breaks or with lack of movement, standing without effective relief (Stock et al., 2005).

The muscle and joints involved in an activity and the amount of force generated are determined by the body posture due to the fact that as the back bends, there is more stress exerted on the spinal discs during object lifting, handling or lowering than when the back is straight. The tasks that also requires repeated twisting or bending of the shoulders, wrist, hips, and the knees also increase the stress on the joint.(Korhan & Ahmed Memon, 2019)

Poor psychosocial work factors could induce work-related musculoskeletal symptoms among employees (George et al., 2014). That is, psychosocial factors such as high work overload (job demand); poor job satisfaction; job control and social support induces occupational low back pain and upper extremity musculoskeletal symptoms (Chiu & Wang, 2007). Subsequently, these affect the ability of employees to work effectively (Han et al., 2009).

Individual factors include age, sex, educational status, body mass index (BMI), number of years worked and marital status Older people who have worked long years and those with high BMI are more prone to MDS's (Ahmad & Alvi, 2017).

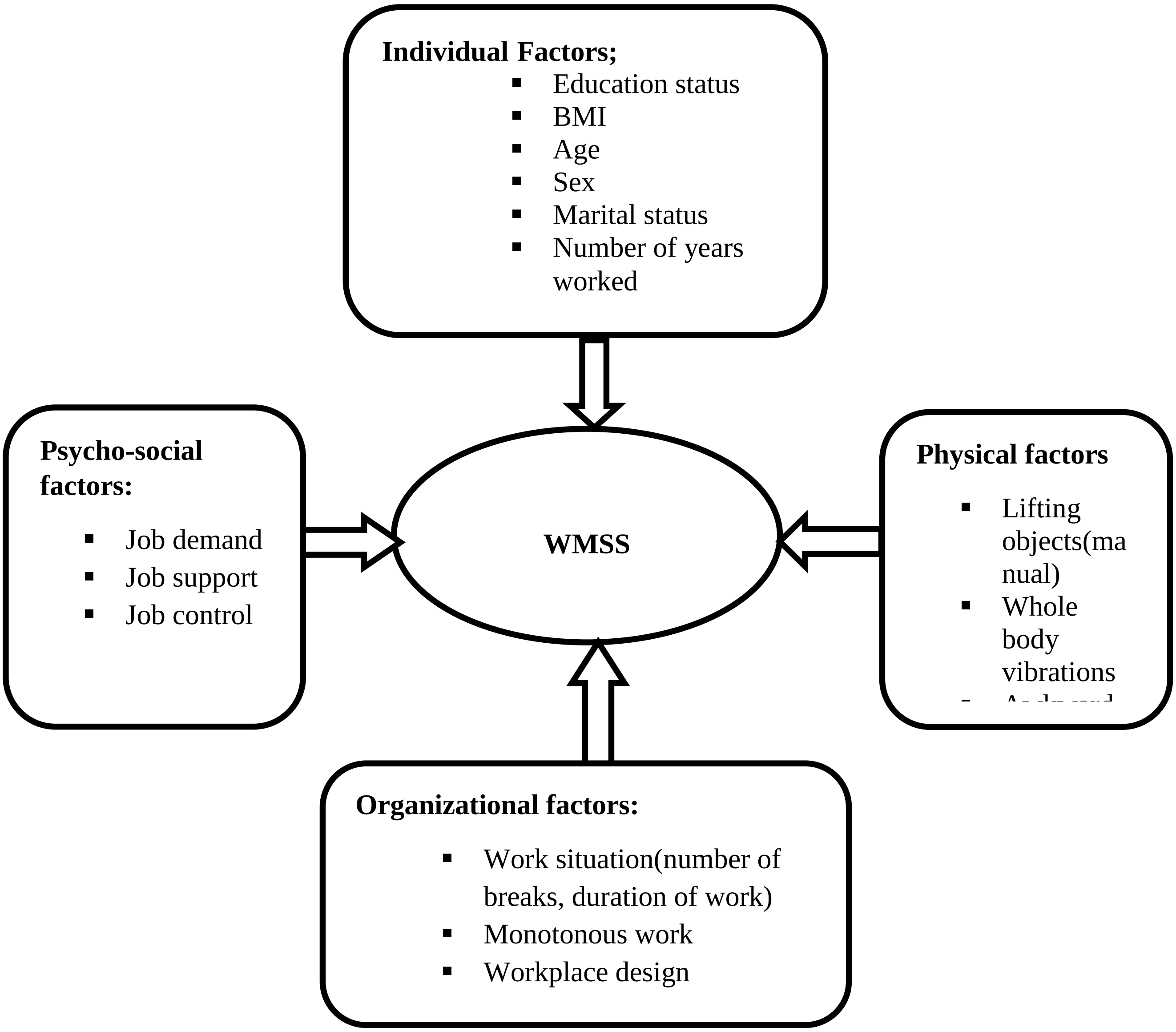


**Figure 1.1: Conceptual framework of factors influencing the risk of work related musculoskeletal symptoms among miners.**

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Scope of the literature review

A comprehensive search of PUBMED and Google scholar was carried out using combinations of the following key words: ergonomics factors, psychosocial factors, awkward postures, postural stress, risk factors, miners, mining, musculoskeletal disorders, musculoskeletal symptoms, low back pain and upper back pain. The researcher identified studies on determinants of musculoskeletal disorders among miners; and only six (6) studies were identified. Due to the limited number of studies on the subject the current literature review considers related studies carried out among professional drivers, oil workers, Healthcare professionals and teachers.

The literature review is in sections. First, definitions and descriptions of musculoskeletal disorders as used in the literature is highlighted. An overview of musculoskeletal disorders and risk factors among miners is discussed. The last section looked into various risk factors that has been associated with musculoskeletal in different occupational groups.

## 2.2 Definition of musculoskeletal disorder

Work-related Musculoskeletal Disorders (WMSDs) are injuries and disorders that affect the human body's movement or the musculoskeletal system that is the tendons, ligaments, nerves, discs and muscles due to the kind of work performed. (Schneider and Irastorza, 2010). Work-related MSDs develop over a period of time such as in weeks, months or even years and this can be due to prolonged mechanical stresses on the musculoskeletal system that results in physical ailments that are marked by pain (Olaseinde Olot, 2011). Musculoskeletal symptoms such as low back pain (LBP), neck, waist and shoulder pains among mineworkers has increased over the years and the major disability it causes continues to cripple the mining industry (Gallagher, 2008).

### 2.3 Overview of Musculoskeletal disorders among miners

This session provides information on studies conducted on musculoskeletal disorders among miners. The mining industry is one of the leading industries as far as musculoskeletal ill-health is concerned (Ammendolia et al., 2009). In Great Britain, it has been reported that MSDs affect around 1 million people a year and are amongst the most frequently reported occupational illnesses among older workers (Silverstein, 2008). Peele et al., (2005) reported that MSD comprised 34% of all work-related injuries in the US and opined that MSDs in working populations might have a more pronounced effect on older workers than young workers. In the mining sector, there are many variables contributing to musculoskeletal disorders (Mine Safety Advisory Council, 2009). The workplace environment and roads are mainly rough, muddy and humid with constrained equipment and bad visibility. (Gallagher, 2005). A study conducted in Kosovo found a prevalence of 61% for WMSS among mineworkers (Nunes & Bush, 2012). Similarly, 64% of coal mine workers suffered WMSS in the lower back, neck and shoulder in China (Xu et al., 2012). In Turkey where 78% of the Turkish coal mineworkers were reported to suffer from WMSS especially in the neck, wrist, shoulder and lower back (Yue, Xu, Li, & Wang, 2014). In another study conducted in India, almost two-thirds (65.45%) suffered musculoskeletal disorders in several body parts, with 58.18% experiencing maximum pain in the lower back of the coal mineworkers (Bandyopadhyay & Gangopadhyay, 2012). WMSS, particularly Low back pain, has been ranked among the most common and difficult occupational health problems and is a major contributor to the high absenteeism rates in the mining industry (Dias, 2014). Absenteeism among affected mineworkers may lead to increased financial cost as sufferers of WMSS spend huge amounts of money on health care. In the United States of America (USA) alone, one hundred to two hundred billion United States dollars are spent annually on medical treatment of work-related musculoskeletal symptoms (Carey & Freburger, 2014). Africa is not spared the WMSS burden, as reported by several researchers. In addition, according to Kunda (2008), the body part mostly affected by underground mineworkers in Zambia was the lower back (44.2%). In Ghana, a study conducted by Bio et al., 2007 found out that drilling and mining are among the highest risk group in the mining team and his study is consistent with other studies conducted by Liebers and Bester. (Bio, Sadhra, Jackson, & Burge, 2007). In a more recent study conducted in another gold mine, WMSS was reported to have the highest percentage in the neck (30%) as against other body parts with in the 12-month prevalence of musculoskeletal disorders (Tawiah, Oppong-Yeboah & Bello, 2015).

### 2.4 WMSD studies in other sectors

Mandal & Srivastava, (2010) reported WMSS in several parts of the body with LBP prevalence of eighty-five percent (85%) amongst dumper operators in India. A study by N. Azma et al indicated that 73.1% of nurses in experienced symptoms of WMSD in their life time and for the 12 month respectively. The body part that were mostly affected were the neck, feet, upper back and shoulders. The consequences of WMSS among the nurses was prevalence of absenteeism or medical leaves.(Azma et al., 2016).

In a different study on the risk factors for work-related musculoskeletal disorders among medical laboratory professionals in India found out that the various workstation used at the laboratory was the main contributory factors. For example the computer work station and pipetting workstation.(Agrawal et al., 2017) . Mohammed Hassan in his study on neck and back pain prevalence in workers in Iranian steel industries in 2015identified the cause of the pain to be physical activities. Example manual material handling and awkward posture. P. Yue (2014) compared the prevalence of WMSD among teachers and miners. Teachers (72%) and miners (78%), miners had a higher prevalence of WMSD, the risk factors were high job demand and the body part mostly affected during a 12-month period was neck, upper limbs, and shoulder and job satisfaction was related to low back pain, lower limb, shoulder and neck among teachers. Among the two sector presented with different characteristics (Yue et al., 2014).

Researchers have identified a higher prevalence of low back pain (MSD) among workers engaged in occupations associated with physically strenuous work involving asymmetric postures, moving, carrying and lifting heavy objects and performing work in poor conditions or bad weather (Bandyopadhyay, Dev, & Gangopadhyay, 2012).

### 2.5 Risk Factors for Work-related Musculoskeletal Symptoms (WMSS)

Smedley, Finlay and Sadhra (2014) reported that some of the risk factors that contributed to the development of WMSS are organisational factors: hours worked, job design, management style; physical factors: forceful exertion, awkward posture examples are hand-arm vibration, whole body vibration, extreme temperatures; individual factors: age, sex, BMI; and psychosocial factors: job demand for example time pressure, work pace, social support from colleagues and management (Nunes, 2009).

#### 2.5.1 Physical Factors and WMSS

Physical risk factors such as awkward posture, forceful exertion, repetitiveness, direct external pressure (stress per contact), and hand-arm vibration, whole body vibration and extreme cold and noise. Many researchers have noted that the main risk factors associated with the operation of heavy equipment are awkward postures, vibrations from jolts and shocks, repeated or continuous use of muscles (Jorgensen et al., 2007, Middleworth, 2016).

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

Postures assumed while performing a task, whether sitting or standing may involve bending, twisting or relaxing of muscles and joints in certain parts of the body. It is very important to maintain a natural body posture while performing a task in order to avoid discomforts and musculoskeletal injuries. Awkward body Postures assumed for a prolonged period poses significant stress on the back (Stock et al., 2005).

Mehta and Tiwari (2000) indicated that heavy equipment operators had to do a lot of turning, bending and twisting movements in the body to look ahead, behind, sideways or downwards while performing tasks that constitutes awkward body posture, an important risk factor for MSDs. Stock et al., (2005) confirmed that heavy equipment operators like forklift drivers have to adopt a posture that exerts intense strains on the back since they have to drive backs up and look behind while twisting the back (Hossain et al., 2018).

Kumar (2001) reported that maintaining awkward postures over an extended period of time increases the risk of developing MSDs. Awkward postures have been associated with work-related musculoskeletal discomforts and injuries to the lower back and neck (Chowdhury, Boricha & Yardi, 2012).

Okunribido et al. (2010) also emphasized that operators of heavy equipment who work in a twisted and bent position have increased pressure in their vertebral discs as well as strains in their necks and shoulders. Awkward postures, therefore, are a major contributing factor for the increased risk of WMSS in forklift drivers and crane operators who usually twist and bend forward while driving (Hoy et al., 2005).

Awkward postures can also be influenced by other factors such as visual field, seating quality, workplace setting, individual work techniques and the workers' anthropometric features (Widanarko et al., 2012). For example, the interior design of a vehicle will determine the postures and postural movements that an operator will assume which in turn has a direct effect on how safely and efficiently a task can be accomplished (Da Costa & Vieira, 2010). Poorly designed cabins of heavy equipment may result in the operators assuming awkward postures which can lead to pain and musculoskeletal injuries. Prolonged sitting and static postures have been positively associated with Work-related Musculoskeletal symptoms of the neck, shoulder and lower part of the back (Alipour, 2008).

Furthermore, reports from other studies indicated that musculoskeletal symptoms involving lower back pain and damages to the spinal discs are common among heavy equipment operators such as persons who drive buses, loader lorries, cranes and fork-lift trucks (Chisenge, 2017). The main factors noted for influencing exposure to WBV are vibration of the vehicle because of wear and tear, the design, seating and the suspension of the vehicle, the surface of the road and the road speed. Vibrations can be transmitted through seats causing the whole body to vibrate.

Health and Safety Executive (2016) confirmed that factors that cause WBV travel from the driver's seat to the body through the buttocks or from the machine to the feet of the operator which in turn cause damage to the back. WBV can also originate from the steering wheel which exposes the operator to hand vibration or from the headrest which leads to head vibration. Drivers exposed to WBV for an extended time period have been associated

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

### 2.5.2 Psychosocial factors influencing WMSS

Psychosocial risk factors are divided into job demand, job support and job control at the workplace. Miners are exposed to psychosocial factors such as high demand, low control and low job satisfaction which contribute greatly to WMSS such as low back pain (Smedley et al., 2014). Furthermore, Eatough et al., (2012) indicated that not having controls over a job, low job satisfaction and working in an unsafe environment increases heavy equipment operators stress levels which may result in WMSS of the wrist, hand, shoulders and low back pain. (Widanarko, Legg, Devereux, & Stevenson, 2015)

The interpersonal relationships at work; relations with supervisor and workers and social like prestige and status in society (Widanarko et al., 2014).

When the psychological perceptions of the work are negative, there may be negative reactions to physiological and psychological stress. These reactions can lead to physical problems; such as muscle tension. On the other hand, workers may have an inappropriate behaviour at work, such as the use of incorrect working methods, the use of excessive force to perform a task or the omission of the rest periods required to reduce fatigue. Any of these conditions can trigger WMSS (Ziaei et. al., 2018)

Johanning (2000), stated that certain non-physical factors such as the perception of intensified workloads, limited job control and job satisfaction, low social support and low morale can all contribute to the development of WMSS.

### 2.5.3 Organizational Risk Factors influencing WMSS

Organizational characteristics, work situation for example, breaks, duration of work, job rotation work and deadlines. Poor work procedures and poor planning coupled with strict deadlines for mining workers is a contributing factor to the development of WMSS (Schneider, 2001). The mining industry is labour intensive and incorporates parallel activities at the same time which exposes workers to multiple risk factors. Most contractors have strict deadlines to meet and as a result mining workers are at times exposed to long working hours, a lack of job rotation contribute to the development of WMSS among mining workers. Best practices like job rotation have been found to reduce the cases of WMSS among production workers in highly repetitive jobs with heavy loads (Bao et al., 2000). This has been shown to help in cost reduction and promotion of health of workers (Burton & Kendall, 2014).

Mining activities are highly repetitive, static and physically demanding hence job rotation if practised can help in reducing cases of musculoskeletal symptoms.

### 2.5.4 Individual Risk Factors influencing WMSS

Individual lifestyle factors namely age, gender and pre-existing health conditions (Cui et al., 2015) A cross-sectional study of 280 male underground gold miners in a mine in Ghana found the twelve-month prevalence of lower back pain among miners was 67% (comparable with data obtained from other studies in Africa and Europe) (Bio et al., 2007). The mean age of the workers was 40 years (SD ± 5.6, ranging from 27 to 53 years). Increasing age was associated with lower back pain. Prevalence of lower back pain was highest among workers performing engineering (82%), blasting (77%) and supervisory (72%) work. Mineworkers with a Body Mass Index (BMI) of over 23 had a higher prevalence of lower back pain. In his study, over-reporting to gain sympathy was identified in the study as a potential source of bias. (Bio et al., 2007). In another study by Sarikaya et al., fifty underground workers (Group I) and 38 age-matched surface workers (Group II) were included in a study to investigate the relationship between angles of the lumbar spine and lower back pain in coal miners. The prevalence of lower back pain among these Turkish coal miners was 78.0% compared to 32.4% among age-matched surface workers. There was no difference in the measure of functional disability between Group I and Group II but Group I reported more severe lower back pain. The low number of controls due to an insufficient number of surface workers in this study may potentially bias the results. (Sarikaya et al., 2007) There are fewer female workers in the mining industry.

## 2.6 Conclusion

Miners face a multitude of hazards in the mining industry. Occupational injuries contribute significantly to the burden of occupational hazards in the mining industry and employees continue to face a greater risk of deadly injury.  Despite improvements in mining sector working conditions, fatal injury rates in mining industry is four times higher than the average. On numerous occasions in the mining industry's history, attempts to enhance this condition through legislation have proven futile.

# CHAPTER THREE

# METHODS

## 3.1 Study Location

Goldfields Ghana Limited (GFG) is currently the number one gold mining company in Ghana, with annual production exceeding 935,000 ounces from its two operating mines in Damang and Tarkwa. Gold Fields Ghana directly employs about 5,612 Ghanaians. Goldfields Ghana focuses on generating value for its company partners, offering staff with a secure and healthy job setting and meeting all regulatory requirements, thus Goldfields Ghana (Tarkwa mines) was selected as the region of research.

Goldfields Ghana Limited has eight departments, namely, Human Resources, Engineering, Processing, Health, Safety and Environment, Metallurgy, Sustainable development and Transportation, Heavy Mining Equipment (HME) and Mining. The Study is limited the HME and the Mining departments. The mining department is responsible for drilling, blasting and extraction of the ore. The Heavy Mining Equipment (HME) are responsible for operating the heavy equipment such as mining tractors, excavators, loaders and crushers. They also play a maintenance role in the organization. The work in these two departments involve manual handling and lifting of objects as well as the assumption of awkward of postures.

## 3.2 Study Design

The study adopted a cross-sectional study design, a quantitative method was used to assess the risk factors associated with work-related musculoskeletal symptoms among miners in Goldfields Ghana, Tarkwa.

### 3.3 Source/study Population

The source population included all 300 workers in the Heavy Mining Equipment (HME) and mining departments. From the 300 workers 180 randomly selected for the current study (see sections 3.6 and 3.5 for sampling methods and sample size calculation).

### 3.4 Study Variables

#### 3.4.1 Independent Variables

The main independent variables were categorized into four (4) risk factors associated with Work-related musculoskeletal symptoms as: (i) physical work factors (awkward posture: working overhead, back bent forward. Bending, wrist bent back or forward and twisting, whole-body vibration, hand down vibration and lifting of heavy objects), (ii) individual factors (age, sex, educational status, marital status and BMI) and (iii) psychosocial work factors (e.g. job control, job demand and social) (Karasek and Theorell, 1990) and (iv) organizational work factors (e.g. working schedule, working hours, break rest).

#### 3.4.2 Dependent Variable

The outcome of the study was work-related musculoskeletal symptoms defined as the symptoms in the back, neck, shoulder, and knee and wrist in the last 12 months.

### 3.5 Sample Size Calculation

Using the sample size formula by Yamane (1967) for cross-sectional study:

$$n = \frac{N}{1+Ne^2} \dots\dots\dots\dots\dots\dots\dots\dots\dots.(1)$$

Where: n = corrected sample size

N = Total population = 300 (HR, Tarkwa Mines 2019).

e = Margin of error set at 0.05.

$$n = \frac{300}{1+300(0.05)^2}$$

$$n = \frac{300}{1.75} = 171$$

The sample size considering a 5% non-response rate is 180 of the mine workers.

The Yamane was chosen because of the finite population.

### 3.6 Sampling methods

Proportionate stratified random sampling technique was used in selecting participants for this study. The proportion of miners sampled from each department were based on total population of people in each department (see Table 1). Staff list was obtained from each of the two departments in Table 1 and a simple random sampling was employed to obtain the required number of sample population. That is, in the mining department 115 individuals were randomly selected and 65 was also selected from HME.

**Table 1: Proportionate distribution of workers in each department**

| Departments | No of workers | No of workers proportionated | Number of sampled workers |
|---|---|---|---|
| HME | 192 | 192/300*180 = 115 | 115 |
| Mining | 108 | 108/300*180 = 65 | 65 |
| **Total** | **300** | **300** | **180** |

### 3.7 Inclusion criteria

Workers who have worked with the company for one year or more and were willing to follow the study protocols were considered. Those available during the data collection and agreed to partake in the study were also included in the research.

### 3.8 Exclusion criteria

Newly recruited workers with less than one-year work experience and those on annual leave/absent and those who refused to participate in the study were excluded from this research.

### 3.9 Data collection and analysis

#### 3.9.1 Data Collection Tool

The questionnaire was divided into sections. The first section was on socio-demographic factors and it captures information on age, rank, sex, marital status and educational levels. Section 2, dealt with physical and psychosocial factors at work. The physical factors included lifting objects weighing more than 25 kg (Fernandez et al, 2014) and exposure to whole body or hand-arm vibration. The Karasek and Theorell (1990) Job content Questionnaire was used to assess work-related psychosocial factors and this included job demand, job control and workplace social support**.** Questions on job demand included "My job requires that I learn new things", "My job involves a lot of repetitive work", "My job requires me to be creative", "I get to do a variety of things on my job", "My job requires working very fast", "My job requires working very hard", "My job requires lots of physical effort" and "I am asked to do an excessive amount of work'. Questions on job control included "My job allows me make a lot of decision on my own", "I am allowed to decide how to do my work" and "I have a lot to say about what happens on my job". Questions on job support included "My supervisor pays attention to what I am saying", "If work gets difficult, my colleagues will help me" and "People I work with are getting the job done". Each of the concept of stress was graded on a 4-point scale (strongly agree, agree disagree and strongly disagree). The Cornell musculoskeletal discomfort measurement tool (CMDQ) was used section three to assess musculoskeletal symptoms (Omidi et al., 2017). This questionnaire is divided into three parts; the discomfort during the last work week and how often one experienced aches, pains or discomforts in the 12 body parts; how severe the experience of aches, pains or discomforts were; and lastly how the aches, pains and discomforts interfered with the participant's ability to perform work over the last 12 months while on duty.

### 3.9.2 Data collection procedure

A meeting was held with managers and supervisors of the departments. Another meeting was held with all mine workers explaining the purpose of the study to them in the change house.

Questions in the questionnaire were explained to them to ensure clarity. The mine workers were assured of the confidentiality of any data collected from them. Research Assistants were trained on data collection methods as well as on the ethics of data collection and for clarity by the participants during the filling of the questionnaire. The process started with the morning shift from 8am to 10am and the night shift from 6pm to 8pm. The participants were assembled during each shift and questionnaires was explained, consent form sought and questionnaire distributed to the participants and collected after completion. The questionnaire was designed in English because the English language was the minimum qualification for employment at the Mine.

## 3.10 Data Processing and Analysis

Completed questionnaires were cross-checked and the data was coded and entered into a Microsoft Excel spreadsheet. The Data was then imported into Stata Version 13. Descriptive statistics including frequency, percentages and tables were used to describe data. Bivariate analysis using Chi-square was performed to test the associations between independent variables and development of work related musculoskeletal symptoms. Multiple logistic regression analysis was carried out on all related factors (significant and not significant), crude (cOR) and adjusted odds ratio (AOR) were computed and statistical significance was set at $p$ <0.05.

### 3.11 Quality control

To ensure the reliability of the data, research assistants were trained to assist in data collection. At the end of each day, data abstraction forms and questionnaires were double-checked for completeness and accurateness. Meetings were held after collection of data to identify any challenges and propose subsequent solutions to them.

### 3.12 Ethical considerations

Ethical issues involved in the study were addressed by doing the following.

#### 3.12.1 Ethical Issues

Ethics approval was obtained from the Ghana Health Service-Ethics Review Committee through the School of Public Health with reference number GHS-ERC 044/04/19.

#### 3.12.2 Approval from the study area

Approval was secured after a letter of introduction from the Department of Biological, Environment and Occupational Health, School of Public Health (SPH), University of Ghana was sent through the Health Service Director, Goldfields Ghana (Tarkwa mines) to the Learning and Development Department for approval for data collection from the various departments and allow the easy access to information needed to complete the study.

#### 3.12.3 Informed consent

Consent was sought from workers prior to participating in the study. The subjects of the study were workers from the Mining and Heavy Mining Equipment departments of the company

### 3.12.4 Potential risks/benefits

The researcher did not anticipate any potential risks of participation to participants. Most of the questions were not sensitive to inflict any emotional injury on participants.

### 3.12.5 Privacy/Confidentiality

Participants were assured of confidentiality and privacy of the information provided.

### 3.12.6 Data storage and usage

Information was gathered with a structured questionnaire. The research instrument (questionnaire) containing the data was saved under lock and key accessible only to the principal investigator.

### 3.12.7 Description of the Consenting Process

The purpose of the study was provided to the research participants. A participant's consent form (Appendix A) was designed and used for the participants.

### 3.12.8 Voluntary withdrawal

Participants were assured that participation in this research was completely voluntary. They were informed that they were free to withdraw their consent and discontinue participation in the study at any time without prejudice from the study team.

### 3.12.9 Compensation

Respondents were not provided with any reward/compensation to respond to the questionnaire.

### 3.12.10 Declaration of conflict of interest

There was no conflict of interest.

### 3.12.11 Funding information

The entire work was funded by the principal investigator

# CHAPTER FOUR

# RESULTS

## 4.1 Socio-demographic characteristics of respondents

The background characteristics of the respondents are presented in Table 4.1. Most respondents were between the ages of 30-39 years (45.6%) and the mean age was 38.4 ± 0.63. Majority (98.3%) were males and most (86.1%) were married. Majority of respondents (75%) had attained SHS/vocational or technical training and most (63.9%) had worked in the mining and heavy maintenance equipment. In addition, 70.6% were overweight. Most respondents had served with the company for at most 6 years (42.8%) and 60% were engaged as full time and 40% were engaged as contract staff.

**Table 4.1 : Socio-demographic characteristics of respondent's (N=180)**

| Variable | Frequency | % |
|---|---|---|
| **Age of respondents (Yrs.)** | | |
| 20-29 | 80 | 11.1 |
| 30-39 | 82 | 45.6 |
| ≥40 | 78 | 43.3 |
| Mean ± SD 38.4 ± 0.63 (95% CI: 37.1-39.6) | | |
| **Sex** | | |
| Male | 177 | 98.3 |
| Female | 3 | 1.7 |
| **Marital status** | | |
| **Married | 155 | 86.1 |
| *Single | 25 | 13.9 |
| **Educational level** | | |
| JSS/Middle school/primary school | 18 | 10.0 |
| SHS/vocational or technical training | 135 | 75.0 |
| Tertiary | 27 | 15.0 |
| **BMI (Kg/m$^2$)** | | |
| 18-25 (Normal) | 39 | 21.7 |
| 26-30 (Over weight) | 127 | 70.6 |
| >30 (obese) | 14 | 7.7 |
| Mean ± SD 26.3± 1.94 (95% CI: 25.89-26.66) | | |
| **Department** | | |
| Mining | 65 | 36.1 |
| HME | 115 | 63.9 |
| **Number of years worked** | | |
| ≤6 | 77 | 42.8 |
| 7-12 | 59 | 32.8 |
| ≥13 | 44 | 24.4 |
| **Working Category** | | |
| Contract staff | 72 | 40.0 |
| Full time staff | 108 | 60.0 |

SD represent standard deviation; CI: Confidence interval; HE: Heavy Mining Equipment
**married and cohabiting; *separated, divorced, widowed and never married

## 4.2 Psychosocial factors and physical factors

The results showed that 78.3% of workers had high job demand. Majority representing 95% and 95.7% had high job support and job control respectively. Majority (55.0%) were found to be lifting objects weighing more than 25kg for 1-5 times in a day. Majority (72.8%) were found to handle objects that cause their hand to vibrate and 55.6% Operate machines that cause whole body vibration (Table 4.2).

**Table 4.2 psychosocial and physical characteristics of respondent's**

| Variable | Frequency | % |
|---|---|---|
| **Psychosocial Factors** | | |
| **Job demand** | | |
| Low | 8 | 4.4 |
| Moderate | 31 | 17.2 |
| High | 141 | 78.3 |
| **Job support** | | |
| Low | - | - |
| Moderate | 9 | 5.0 |
| High | 171 | 95.0 |
| **Job control** | | |
| Moderate | 5 | 3.3 |
| High | 175 | 96.7 |
| **Physical factors** | | |
| **Number of times lifting objects weighing >25kg daily** | | |
| None | 69 | 38.3 |
| 1-5 times | 99 | 55.0 |
| >5 times | 12 | 6.7 |
| **Number of times lifting objects weighing < 25kg daily** | | |
| None | 83 | 46.1 |
| 1-5 times | 84 | 46.7 |
| >5 times | 13 | 7.2 |
| **Handle objects that causes hand to vibrate** | | |
| No | 49 | 27.2 |
| Yes | 131 | 72.8 |
| **Operate machines that cause whole body vibration** | | |
| Yes | 100 | 55.6 |
| No | 80 | 44.4 |

### 4.3 Prevalence of WMSS among mine workers in Tarkwa mines

The results of this study shows that the body parts with high proportion of WMSS of among miners of Goldfields Ghana Limited were; Forearm (94.4%), upper arm (69.4%) and lower back (52.8%). Specifically, the results on the prevalence of pain in various parts of body are illustrated in Table 4.3. It was revealed that workers also felt discomfort at the upper back (43.9%) and left shoulder (43.8%), neck (40%) and knee (36.7%) while it was less pronounced in the foot, lower leg, wrist and thigh (Table 4.3).

**Table 4.3 Prevalence of body pain among miners in Tarkwa mines**

| Variable | Frequency | % |
|---|---|---|
| **Neck pain*** | | |
| Ever | 72 | 40.0 |
| Never | 108 | 60.0 |
| **Shoulder pain*** | | |
| Ever | 77 | 42.8 |
| Never | 103 | 57.2 |
| **Upper back pain*** | | |
| Ever | 79 | 43.9 |
| Never | 101 | 56.1 |
| **Upper arm pain*** | | |
| Ever | 125 | 69.4 |
| Never | 55 | 30.6 |
| **Lower back pain*** | | |
| Ever | 95 | 52.8 |
| Never | 85 | 47.2 |
| **Fore arm*** | | |
| Ever | 170 | 94.4 |
| Never | 10 | 5.6 |
| **Wrist pain*** | | |
| Ever | 21 | 11.7 |
| Never | 159 | 88.3 |
| **Hip pain*** | | |
| Ever | 30 | 16.7 |
| Never | 150 | 83.3 |
| **Thigh pain*** | | |
| Ever | 19 | 10.6 |
| Never | 161 | 89.4 |
| **Knee pain*** | | |
| Ever | 66 | 36.7 |
| Never | 114 | 63.3 |
| **Lower leg pain*** | | |
| Ever | 28 | 15.6 |
| Never | 152 | 84.4 |
| **Foot pain*** | | |
| Ever | 30 | 16.7 |
| Never | 150 | 83.3 |
| **Overall Musculoskeletal symptoms** | | |
| No | 155 | 86.1 |
| Yes | 25 | 13.9 |

***Multiple response**

### 4.4 Bivariate association between demographic characteristics and Forearm WMSS

A bivariate analysis was performed to test the association between socio-demographic and other variables and body parts that had high prevalence of WMSS at 5% level of significance. This included; forearm, upper arm and lower back. With respect to the forearm, the results showed that there was a statistically significant association between

Job demand and WMSS of the forearm ($\chi2$ = 6.627; *p* = 0.044). Type of department was also found to be significantly associated with WMSS of the forearm of miners ($\chi2$ = 1.764; *p* = 0.003). The sex, educational level, age, number of years worked, BMI and marital status were assessed but were not statistically associated with WMSS of the forearm (p>0.05) (Table 4.4).

**Table 4.4 Test of Association between demographic characteristics and symptoms in the forearm among miners in Tarkwa.**

| | Forearm N (%) | | | Fisher's exact | p-value |
|---|---|---|---|---|---|
| | **Yes** | **No** | **Total** | | |
| **Age (yrs)** | | | | 0.9311 | 0.628 |
| 20-29 | 19 (11.2) | 1 (10) | 20 (11.1) | | |
| 30-39 | 76 (44.7) | 6 (60) | 82 (45.6) | | |
| ≥40 | 75 (44.1) | 3 (30) | 78 (43.3) | | |
| **Sex** | | | | 0.179 | 0.672 |
| Male | 167(98.2) | 10 (100.0) | 177 (98.3) | | |
| Female | 3 (1.8) | 0 (0.0) | 3 (1.7) | | |
| **Marital status** | | | | 0.134 | 0.714 |
| **Married | 146 (85.9) | 9 (90.0) | 155 (86.1) | | |
| *Single | 24 (14.1) | 1 (10.0) | 25 (13.9) | | |
| **Educational level** | | | | 1.553 | 0.460 |
| JSS/ Middle school | 18 (10.6) | 0 (0.0) | 18 (10.0) | | |
| SHS/VOC training | 126 (74.1) | 9 (90.0) | 135 (75.0) | | |
| Tertiary | 26 (15.3) | 1 (10.0) | 27 (15.0) | | |
| **BMI** | | | | 0.971 | 0.615 |
| 18-25 (Normal) | 37 (21.8) | 2 (20.0) | 39 (21.7) | | |
| 26-30 (Over weight) | 119 (70.0) | 8 (80.0) | 127 (70.6) | | |
| >30 (obese) | 14 (8.2) | 0 (0.0) | 14 (7.7) | | |
| **Number of years worked** | | | | 2.376 | 0.305 |
| ≤6 | 75(44.1) | 2 (20.0) | 77(42.8) | | |
| 7-12 | 54 (31.7) | 5 (50.0) | 59 (32.8) | | |
| ≥13 | 41 (24.2) | 3 (30.0) | 44 (24.4) | | |
| **Department** | | | | 8.840 | 0.003* |
| Mining | 57 (33.5) | 8 (80.0) | 65 (36.1) | | |
| HME | 113 (66.5) | 2 (20.0) | 115 (63.9) | | |
| **Working category** | | | | 1.764 | 0.184 |
| Contract staff | 70 (41.2) | 2 (20.0) | 72 (40.0) | | |
| Full time staff | 100 (58.8) | 8 (80.0) | 108 (60.0) | | |

*Significant at p<0.05 HME-Heavy Mining Equipment
**married and cohabiting; *separated, divorced, widowed and never married

Assessing the psychosocial factors influencing WMSS, the study did not find a significant association between job support, Job control, number of times lifting objects weighing >25kg daily. However, job demand was found to influence WMSS (p-value= 0.044) (Table 4.5). Assessing the physical factors associated with WMSS, it was realized that lifting weight >25kg (p-value< 0.001) and lifting weight < 25kg (p-value= 0.002) were associated WMSS. Handling objects that vibrates the hand was associated with developing WMSS (p-value< 0.001)

**Table 4.5: Test of Association between psychosocial and physical factors and WMSS of the forearm among miners in Tarkwa.**

| | Forearm N (%) Yes | No | Total | Fischer's exact | p-value |
|---|---|---|---|---|---|
| Psychosocial factors | | | | | |
| Job demand | | | | | |
| **Low** | 6 (3.5) | 2 (20.0) | 8 (4.4) | 6.27 Ψ | 0.044* |
| **Moderate** | 29 (17.0) | 2 (20.0) | 31 (17.2) | | |
| **High** | 135 (79.5) | 6 (60.0) | 141 (78.4) | | |
| Job support | | | | 0.42 Ψ | 0.513 |
| **Low** | - | - | - | - | - |
| **Moderate** | 7(4.1) | 2(20.0) | 9(5.0) | | |
| **High** | 163 (95.9) | 8 (80.0) | 171 (95.0) | | |
| Job control | | | | 0.11 Ψ | 0.730 |
| Low | - | - | - | - | - |
| **Moderate** | 2 (1.2) | 3 (30.0) | 5 (2.8) | | |
| **High** | 168 (98.8) | 7 (70.0) | 175 (97.2) | | |
| Physical factors | | | | | |
| Number of times lifting objects weighing >25kg daily | | | | | |
| **None** | 59 (34.7) | 10 (100.0) | 69 (38.3) | 17.03 Ψ | <0.001* |
| **1-5 times** | 99 (58.2) | 0 (0.0) | 99 (55.0) | | |
| **>5 times** | 12 (7.1) | 0 (0.0) | 12 (6.7) | | |
| Number of times lifting objects weighing < 25kg daily | | | | 12.37 Ψ | 0.002* |
| **None** | 73 (42.9) | 10 (100.0) | 83 (46.1) | | |
| **1-5 times** | 84 (49.4) | 0 (0.0) | 84 (46.7) | | |
| **>5 times** | 13 (7.7) | 0 (0.0) | 13 (7.2) | | |
| Handle objects that causes hand to vibrate | | | | 14.89 Ψ | <0.001* |
| **No** | 129 (75.9) | 2 (20.0) | 49 (27.2) | | |
| **Yes** | 41 (24.1) | 8 (80.0) | 131 (72.8) | | |
| Operate machines that cause whole body vibration | | | | 2.56 Ψ | 0.109 |
| **No** | 92 (54.1) | 8 ( 80.0) | 100 (55.6) | | |
| **Yes** | 78 (45.9) | 2 (20.0) | 80 (44.4) | | |

***Significant at p<0.05** Ψ represents fishers exact value

### 4.5 Multiple Logistic regression of WMSS of the forearm

Multiple logistic regression analysis was conducted on all factors and these factors were found to be significant associated with Symptoms of the forearm among miners; Type of department, working category and job demand. Miners who worked as full time staff had 75% reduced odds of experiencing work related musculoskeletal symptoms of the forearm compared to workers who worked as contract staff (AOR=0.25; 95% CI= 0.36-0.81). The odds of experiencing work related musculoskeletal symptoms of the forearm among miners who are in the heavy mining equipment department was approximately 6 times the odds of experiencing WMSS among miners who are in the mining department (AOR= 5.87; 95% CI=1.74-9.74).

The odds of experiencing symptom of the forearm among miners with high job demand was 6.4 times the odds of experiencing WMSS of the forearm among miners with low job demand (AOR= 6.4; 95% CI=4.63-9.76) (Table 4.6).

**Table 4.6 Multiple Logistics regression of the factors associated with WMSS of forearm among miners**

| Variable | Forearm Yes | No | cOR (95%Cl) | AOR(95%CI) | p-value |
|---|---|---|---|---|---|
| **Socio-demographic factor** | | | | | |
| **Age (yrs)** | | | | | |
| 20-29 | 19 (11.2) | 1 (10) | 1.0 (ref) | 1.0 (ref) | |
| 30-39 | 76 (44.7) | 6 (60) | 0.67 (0.76-3.87) | 0.48 (0.83-4.63) | 0.253 |
| ≥40 | 75 (44.1) | 3 (30) | 1.32 (0.13-4.37) | 1.42 (0.33-4.67) | 0.085 |
| **Number of years worked** | | | | | |
| ≤6 | 75 (44.1) | 2 (20.0) | 1.0 (ref) | 1.0 (ref) | |
| 7-12 | 54 (31.7) | 5 (50.0) | 0.28 (0.05 -1.54) | 0.25 (0.03-2.00) | 0.191 |
| ≥13 | 41 (24.2) | 3 (30.0) | 0.36 (0.05-2.27) | 0.52 (0.03-2.52) | 0.093 |
| **Department** | | | | | |
| Mining | 57 (33.5) | 8 (80.0) | 1.0 (ref) | 1.0 (ref) | |
| HME | 113 (66.5) | 2 (20.0) | 7.92 (1.63-9.57)* | 5.87 (1.74-9.74) | 0.04* |
| **Working category** | | | | | |
| Contract staff | 70 (41.2) | 2 (20.0) | 1.0 (ref) | 1.0 (ref) | |
| Full time staff | 100 (58.8) | 8 (80.0) | 0.36 (0.24-0.73)* | 0.25 (0.36- 0.81) | 0.017* |
| **Physical factors** | | | | | |
| **Handle objects that causes hand to vibrate** | | | | | |
| No | 129 (75.9) | 2 (20.0) | 1.0 (ref) | 1.0 (ref) | |
| Yes | 41 (24.1) | 8 (80.0) | 0.36 (0.07-1.73) | 0.51 (0.08- 2.67) | 0.145 |
| **Operate machines that cause whole body vibration** | | | | | |
| No | 92 (54.1) | 8 ( 80.0) | 1.0 (ref) | 1.0 (ref) | |
| Yes | 78 (45.9) | 2 (20.0) | 3.39 (0.70-5.44) | 2.56 (0.40- 6.16) | 0.319 |
| **Psychosocial factors** | | | | | |
| **Job demand** | | | | | |
| Low | 6 (3.5) | 2 (20.0) | 1.0 (ref) | 1.0 (ref) | |
| Moderate | 29 (17.0) | 2 (20.0) | 4.83(1.27-7.33)* | 4.18(1.48-8.43) | 0.062 |
| High | 135 (79.5) | 6 (60.0) | 7.5 (2.57-9.35)* | 6.4 (4.63-9.76) | 0.015* |

***Significant at p<0.05**

### 4.6 Bivariate association between demographic characteristics and WMSS of the lower back among miners

A bivariate analysis was performed to examine the relationship between socio-demographic and symptoms of lower back. The results showed that, BMI ($\chi2 = 6.91$; $p = 0.032$), number of times lifting objects weighing >25kg daily (($\chi2 = 10.99$; $p = 0.004$) and operating machines that cause whole body vibrations ($\chi2 = 8.63$; $p = 0.003$) were the factors found to be significantly associated with symptom of the lower back at 5% level of significance (Table 4.7 and 4.8).

**Table 4.7: Association between socio-demographic characteristics and symptoms of lower back among miners**

| | Lower back N (%) | | | Chi-square value | p-value |
|---|---|---|---|---|---|
| | Yes | No | Total | | |
| **Age (yrs)** | | | | 0.67^ | 0.717 |
| 20-29 | 10 (10.5) | 10 (11.8) | 20 (11.1) | | |
| 30-39 | 46 (48.4) | 36 (42.4) | 82 (45.6) | | |
| ≥40 | 39 (41.1) | 39 (45.8) | 78 (43.3) | | |
| **Sex** | | | | 0.24Ψ | 0.627 |
| Male | 93 (97.9) | 84 (98.8) | 177 (98.3) | | |
| Female | 2 (2.1) | 1 (1.2) | 3 (1.7) | | |
| **Marital status** | | | | 1.90 ^ | 0.168 |
| **Married | 85 (89.5) | 70 (82.4) | 155 (86.1) | | |
| *Single | 10 (10.5) | 15 (17.6) | 25 (13.9) | | |
| **Educational level** | | | | 1.67^ | 0.433 |
| JSS/ Middle school | 7 (7.4) | 11 (12.9) | 18 (10.0) | | |
| SHS/VOC training | 73 (76.8) | 62 (72.9) | 135 (75.0) | | |
| Tertiary | 10 (15.8) | 17 (14.2) | 27 (15.0) | | |
| **BMI** | | | | 6.91 ^ | 0.032* |
| 18-25 (Normal) | 8 (8.4) | 10 (11.8) | 39 (21.7) | | |
| 26-30 (Over weight) | 75 (78.9) | 60 (70.6) | 127 (70.6) | | |
| >30 (obese) | 12 (12.7) | 15 (17.6) | 14 (7.7) | | |
| | | | | 0.38^ | 0.827 |
| **Number of years worked** | | | | | |
| ≤6 | 39 (41.0) | 38 (44.7) | 77(42.8) | | |
| 7-12 | 33 (34.7) | 26 (30.6) | 59 (32.8) | | |
| ≥13 | 23 (24.2) | 21 (24.7) | 44 (24.4) | | |
| **Department** | | | | 3.84^ | 0.060 |
| Mining | 28 (29.5) | 37 (43.5) | 65 (36.1) | | |
| HME | 67 (70.5) | 48 (56.5) | 115 (63.9) | | |
| **Working category** | | | | 1.47^ | 0.223 |
| Contract staff | 34 (35.8) | 38 (44.7) | 72 (40.0) | | |
| Full time staff | 61 (64.2) | 47 (55.3) | 108 (60.0) | | |

*Significant at $p<0.05$ Ψ represents fishers exact value ^ chi –square
**married and cohabiting; *separated, divorced, widowed and never married

**Table 4.8 Association between psychosocial and physical factors and symptoms of lower back pain among miners in Tarkwa**

| | Lower back N (%) | | | Chi-square | p-value |
|---|---|---|---|---|---|
| | **Yes** | **No** | **Total** | | |
| **Psycho-social & physical factors** | | | | 0.81 Ψ | 0.667 |
| **Job demand** | | | | | |
| Low | 3 (3.2) | 5(5.9) | 8 (4.4) | | |
| Moderate | 17 (17.9) | 14 (16.5) | 31 (17.2) | | |
| High | 75 (78.9) | 66 (77.6) | 141 (78.4) | | |
| **Job support** | | | | 3.17 Ψ | 0.075 |
| Moderate | 6 (6.3) | 1(1.2) | 7 (3.9) | | |
| High | 89 (93.7) | 84 (98.8) | 173 (96.1) | | |
| **Job control** | | | | 1.80 Ψ | 0.179 |
| Moderate | 2 (2.1) | 0 (0.0) | 2 (1.1) | | |
| High | 93 (97.8) | 85 (100.0) | 178 (98.8) | | |
| **Number of times lifting objects weighing >25kg daily** | | | | | |
| None | 27 (28.4) | 42 (49.4) | 69 (38.3) | 10.99 Ψ | 0.004* |
| 1-5 times | 58 (61.1) | 41(48.2) | 99 (55.0) | | |
| >5 times | 10 (10.5) | 2 (2.4) | 12 (6.7) | | |
| **Number of times lifting objects weighing < 25kg daily** | | | | 0.91^ | 0.633 |
| None | 41(43.2) | 42 (49.4) | 83 (46.1) | | |
| 1-5 times | 46 (48.4) | 38 (44.7) | 84 (46.7) | | |
| >5 times | 8 (8.4) | 5 (5.9) | 13 (7.2) | | |
| **Handle objects that causes hand to vibrate** | | | | 0.51^ | 0.473 |
| No | 28 (29.5) | 21 (24.7) | 49 (27.2) | | |
| Yes | 67 (70.5) | 64 (75.3) | 131 (72.8) | | |
| **Operate machines that cause whole body vibration** | | | | 2.56^ | 0.109 |
| No | 52 (54.7) | 28 ( 32.9) | 80 (44.4) | 8.63^ | 0.003* |
| Yes | 43 (45.3) | 57 (67.1) | 100 (55.6) | | |

***Significant at p<0.05 Ψ represents fishers exact value ^ represents chi-square**

### 4.7 Multiple Logistic Regression Analyses between factors and WMSS of lower back

The multiple logistic regression analysis between symptoms and lower back are as summarized in table 4.9 below. The results revealed that, the number of times lifting objects weighing >25kg daily and operate machines that cause whole body vibrations were the factors found to be significantly associated with symptoms of lower back among miners. Miners who lift objects weighing >25kg 1-5 times daily had increased odds of experiencing work related musculoskeletal symptoms of the lower back compared to those who lift none (AOR=1.28; 95% CI= 1.11-2.67). The odds of experiencing symptoms of the lower back among miners who operate machines that cause whole body vibrations was 1.72 times the odds of experiencing WMSS among miners who operate machines that do not cause whole body vibrations (AOR= 1.72; 95% CI=1.24-5.72) (Table 4.9).

**Table 4.9: Multiple Logistics regression of the factors associated with WMSS of lower back pain among miners**

| Variable | Lower back pain Yes | No | cOR (95%Cl) | AOR (95%CI) | p-value |
|---|---|---|---|---|---|
| **Age (yrs)** | | | | | |
| 20-29 | 10 (10.5) | 10 (11.8) | 1.0 (ref) | 1.0 (ref) | |
| 30-39 | 46 (48.4) | 36 (42.4) | 0.78 (0.29-2.08) | 1.01 (0.35-3.00) | 0.972 |
| ≥40 | 39 (41.1) | 39 (45.8) | 0.62 (0.37-2.67) | 1.28 (0.33-4.99) | 0.712 |
| **BMI** | | | | | |
| 18-25 (Normal) | 8 (8.4) | 10 (11.8) | 1.0 (ref) | 1.0 (ref) | |
| 26-30 (Over weight) | 75 (78.9) | 60 (70.6) | 0.44 (0.21-0.93)* | 0.43 (0.19-1.01) | 0.062 |
| >30 (obese) | 12 (12.7) | 15 (17.6) | 0.22 (0.06-0.85)* | 0.24 (0.06-1.01) | 0.065 |
| **Number of years worked** | | | | | |
| ≤6 | 39 (41.0) | 38 (44.7) | 1.0 (ref) | 1.0 (ref) | |
| 7-12 | 33 (34.7) | 26 (30.6) | 0.80 (0.41 -1.60) | 1.14 (0.44-2.93) | 0.792 |
| ≥13 | 23 (24.2) | 21 (24.7) | 0.94 (0.45-1.97) | 1.24 (0.35-4.46) | 0.741 |
| **Department** | | | | | |
| Mining | 28 (29.5) | 37 (43.5) | 1.0 (ref) | 1.0 (ref) | |
| HME | 67 (70.5) | 48 (56.5) | 0.54 (0.29-1.12) | 0.65 (0.32-1.33) | 0.241 |
| **Working category** | | | | | |
| Contract staff | 34 (35.8) | 38 (44.7) | 1.0 (ref) | 1.0 (ref) | |
| Full time staff | 61 (64.2) | 47 (55.3) | 0.68 (0.38-1.25) | 0.49 (0.24- 1.04) | 0.060 |
| **Number of times lifting objects weighing >25kg daily** | | | | | |
| None | 27 (28.4) | 42 (49.4) | 1.0 (ref) | 1.0 (ref) | |
| 1-5 times | 58 (61.1) | 41(48.2) | 1.22 (0.07-1.73) | 1.28 (1.11- 2.67) | 0.042* |
| >5 times | 10 (10.5) | 2 (2.4) | 0.128 (0.03-1.45) | 0.75(0.274-2.35) | 0.062 |
| **Operate machines that cause whole body vibration** | | | | | |
| No | 52 (54.7) | 28 ( 32.9) | 1.0 (ref) | 1.0 (ref) | |
| Yes | 43 (45.3) | 57 (67.1) | 2.46 (1.24-5.44) | 1.72 (1.23- 5.72) | 0.002* |
| **Job demand** | | | | | |
| Low | 3 (3.2) | 5(5.9) | 1.0 (ref) | 1.0 (ref) | |
| Moderate | 17 (17.9) | 14 (16.5) | 0.49 (0.10-2.45) | 0.58 (0.08-4.25) | 0.596 |
| High | 75 (78.9) | 66 (77.6) | 0.53(0.12-2.29) | 0.46 (0.07-2.76) | 0.398 |

**4.8 Bivariate association between demographic characteristics and WMSS of upper arm among miners**

A bivariate analysis was performed to examine the relationship between socio-demographic and symptoms of upper arm among miners at 95% confidence level. The results showed that, number of times lifting objects weighing >25kg daily ($\chi 2 = 22.72$; $p < 0.001$), operate machine that causes whole body vibration ($\chi 2 = 25.29$; $p < 0.001$) were the factors found to be significantly associated with symptoms of upper arm pain (Table 4.10 and 4.11).

**Table 4.10: Association between Demographic characteristics and WMSS of upper arm among miners in Tarkwa.**

| | Upper arm N (%) | | | Chi-square value | p-value |
|---|---|---|---|---|---|
| | **Yes** | **No** | **Total** | | |
| **Age (yrs)** | | | | 2.49^ | 0.288 |
| 20-29 | 13 (10.4) | 7 (12.7) | 20 (11.1) | | |
| 30-39 | 53 (42.4) | 29 (52.7) | 82 (45.6) | | |
| ≥40 | 59 (47.2) | 19 (34.6) | 78 (43.3) | | |
| **Educational level** | | | | 6.03 Ψ | 0.065 |
| JSS/ Middle school | 13(10.4) | 5 (9.0) | 18 (10.0) | | |
| SHS/VOC training | 88 (70.4) | 47 (85.5) | 135 (75.0) | | |
| Tertiary | 24 (19.2) | 3 (5.5) | 27 (15.0) | | |
| **BMI** | | | | 3.58 Ψ | 0.372 |
| 18-25 (Normal) | 32(25.6) | 7 (12.7) | 39 (21.7) | | |
| 26-30 (Over weight) | 81 (64.8) | 46 (83.6) | 127 (70.6) | | |
| >30 (obese) | 12 (9.6) | 2 (3.7) | 14 (7.7) | | |
| **Number of years worked** | | | | 0.55 | 0.759 |
| ≤6 | 54 (43.2) | 23 (41.8) | 77(42.8) | | |
| 7-12 | 39 (31.2) | 20 (36.4) | 59 (32.8) | | |
| ≥13 | 32 (25.6) | 12 (21.8) | 44 (24.4) | | |
| **Department** | | | | 0.39 | 0.531 |
| Mining | 47 (37.6) | 18 (32.7) | 65 (36.1) | | |
| HME | 78 (62.4) | 37 (67.3) | 115 (63.9) | | |
| **Working category** | | | | 0.98 | 0.322 |
| Contract staff | 47 (37.6) | 25 (45.5) | 72 (40.0) | | |
| Full time staff | 78 (62.4) | 30 (54.5) | 108 (60.0) | | |

***Significant at p<0.05 HME-Heavy Mining Equipment; Ψ represents fishers exact value**
**^represent chi-square**

**Table 4.11 Association between psychosocial and physical factors and symptoms of upper arm pain among miners in Tarkwa**

| | Upper arm N (%) | | | | |
|---|---|---|---|---|---|
| | **Yes** | **No** | **Total** | **Chi-square** | **p-value** |
| **Psychosocial factors** | | | | | |
| **Job demand** | | | | 1.23 Ψ | 0.540 |
| Low | 5 (4.0) | 3(5.5) | 8 (4.4) | | |
| Moderate | 24 (19.2) | 7 (12.7) | 31 (17.2) | | |
| High | 96 (76.8) | 45 (81.8) | 141 (78.4) | | |
| **Job support** | | | | 0.52 Ψ | 0.471 |
| Moderate | 4 (3.2) | 3(5.5) | 7 (3.9) | | |
| High | 121 (96.8) | 52 (94.5) | 173 (96.1) | | |
| **Job control** | | | | 0.36 Ψ | 0.548 |
| Moderate | 1(0.8) | 1 (1.8) | 2 (1.1) | | |
| High | 124 (99.2) | 54 (98.2) | 178 (98.9) | | |
| **Physical factors** | | | | | |
| **Number of times lifting objects weighing >25kg daily** | | | | | |
| None | 50 (40.0) | 19 (34.5) | 69 (38.3) | 22.73 Ψ | <0.001* |
| 1-5 times | 74 (59.2) | 25 (45.5) | 99 (55.0) | | |
| >5 times | 1 (0.8) | 11 (20.0) | 12 (6.7) | | |
| **Handle objects that causes hand to vibrate** | | | | 3.34^ | 0.068 |
| No | 29 (23.2) | 20 (36.4) | 49 (27.2) | | |
| Yes | 96 (76.8) | 35 (63.6) | 131 (72.8) | | |
| **Operate machines that cause whole body vibration** | | | | 25.29^ | <0.001* |
| No | 71 (56.8) | 9 (16.4 ) | 80 (44.4) | | |
| Yes | 54 (43.2) | 46 (83.6) | 100 (55.6) | | |

***Significant at p<0.05** **Ψ represents fishers exact value ^ represents chi-square**

**4.9 Multiple Logistic Regression Analysis between symptoms of upper arm**

The multiple logistic regression analysis between symptoms of upper arm are as summarized in table 4.4 below. The results revealed that, the number of times lifting objects weighing >25kg daily was the factor found to be significant associated with symptoms of the upper arm among miners. Miners who lift objects weighing >25kg daily had increased odds of experiencing work-related musculoskeletal symptoms of the upper arm compared to workers who lift none (AOR=1.78; 95% CI= 1.36-5.67). The odds of experiencing work- related musculoskeletal symptoms of the upper arm among miners who were overweight was 2.27 times the odds of experiencing WMSS among miners who had normal weight (AOR= 2.27; 95% CI=1.35-5.03) (Table 4.12).

**Table 4.12 Multiple Logistics regression of the factors associated with WMSS of upper arm among miners**

| Variable | Upper arm Yes | No | cOR (95%Cl) | AOR (95%CI) | p-value |
|---|---|---|---|---|---|
| **Age (yrs)** | | | | | |
| 20-29 | 13 (10.4) | 7 (12.7) | 1.0 (ref) | 1.0 (ref) | |
| 30-39 | 53 (42.4) | 29 (52.7) | 1.11 (0.36-2.83) | 0.68 (0.20-2.36) | 0.546 |
| ≥40 | 59 (47.2) | 19 (34.6) | 0.598 (0.21-1.72) | 0.28 (0.05-1.48) | 0.134 |
| **BMI** | | | | | |
| 18-25 (Normal) | 32(25.6) | 7 (12.7) | 1.0 (ref) | 1.0 (ref) | |
| 26-30 (Over weight) | 81 (64.8) | 46 (83.6) | 2.59 (1.06-6.35)* | 2.27 (1.35-5.03) | 0.013* |
| >30 (obese) | 12 (9.6) | 2 (3.7) | 0.76 (0.14-4.19) | 0.38 (0.03-2.03) | 0.465 |
| **Number of years worked** | | | | | |
| ≤6 | 54 (43.2) | 23 (41.8) | 1.0 (ref) | 1.0 (ref) | |
| 7-12 | 39 (31.2) | 20 (36.4) | 1.20 (0.58 -2.49) | 1.97(0.62-6.23) | 0.248 |
| ≥13 | 32 (25.6) | 12 (21.8) | 0.88 (0.39-2.01) | 2.88 (0.56-5.03) | 0.208 |
| **Department** | | | | | |
| Mining | 47 (37.6) | 18 (32.7) | 1.0 (ref) | 1.0 (ref) | |
| HME | 78 (62.4) | 37 (67.3) | 1.24 (0.63-2.42) | 1.22 (0.73-3.33) | 0.784 |
| **Working category** | | | | | |
| Contract staff | 47 (37.6) | 25 (45.5) | 1.0 (ref) | 1.0 (ref) | |
| Full time staff | 78 (62.4) | 30 (54.5) | 0.72 (0.38-1.37) | 0.91 (0.39- 2.14) | 0.837 |
| **Number of times lifting objects weighing >25kg daily** | | | | | |
| None | 50 (40.0) | 19 (34.5) | 1.0 (ref) | 1.0 (ref) | |
| 1-5 times | 74 (59.2) | 25 (45.5) | 2.88 (1.28-4.76)* | 1.78 (1.36- 5.67) | 0.004* |
| >5 times | 1 (0.8) | 11 (20.0) | 0.88 (0.44-1.78) | 0.72 (0.17-3.35) | 0.628 |
| **Operate machines that cause whole body vibration** | | | | | |
| No | 71 (56.8) | 9 (16.4 ) | 1.0 (ref) | 1.0 (ref) | |
| Yes | 54 (43.2) | 46 (83.6) | 0.15 (0.07-1.33) | 0.18 (0.24- 2.72) | 0.245 |
| **Job demand** | | | | | |
| Low | 5 (4.0) | 3(5.5) | 1.0 (ref) | 1.0 (ref) | |
| Moderate | 24 (19.2) | 7 (12.7) | 0.48 (0.09-2.56) | 0.73 (0.07-4.40) | 0.795 |
| High | 96 (76.8) | 45 (81.8) | 0.78 (0.18-3.41) | 0.82 (0.11-2.77) | 0.847 |

# CHAPTER FIVE

# DISCUSSION

## 5.1 Major Findings

The study sought to determine the prevalence and risk factors of work-related musculoskeletal symptoms among miners of Goldfields Ghana Limited (Tarkwa Mine). Factors that were considered were individual, psychosocial, organizational and physical factors.

From the results obtained, it was realized that the overall prevalence of work-related musculoskeletal symptoms among workers of Goldfields Ghana Mines and the body parts with high proportion were; Forearm (94.4%), upper arm (69.4%) and lower back (52.8%) (Table 4.3). The results showed that 78.3% of workers had high job demand. Majority representing 95% and 95.7% had high job support and job control respectively. Majority (55.0%) were found to be lifting objects weighing more than 25kg for 1-5 times in a day. Majority (72.8%) were found to handle objects that cause their hand to vibrate and 55.6% Operate machines that cause whole body vibration.

## 5.2 Methodological Validity

This study has a number of strengths. It has a high participation rate (100%) minimizing the effect of selection bias. The main explanatory variable of interest, work-related musculoskeletal symptom was measured using the Job Content Questionnaire (Karasek and Theorell, 1990). This questionnaire has been used extensively in different cultures and countries and its reliability and validity have been reported (Owolabi, 2012). The outcome of interest was assessed with the Cornell musculoskeletal discomfort Questionnaire.

Thus the efffect of information bias in this study was minimal. Irrespective of the strength of this study, some weaknesses existed.The study used a cross-sectional design, which restricted the ability to discern any temporality. Also , the participants had to recall from past experiences to inform their response thus this study may be subject to recall bias.

### 5.3 Contextual analysis and comparison with other studies

#### 5.3.1 Prevalence of work-related musculoskeletal symptom among miners

The study assessed the prevalence and risk factors of work-related musculoskeletal symptoms among miners of Goldfields Ghana Limited (Tarkwa Mine). From this study, it was realized that the overall prevalence of work-related musculoskeletal symptoms among workers of Goldfields Ghana Mines was 13.9% (Table 4.3). This low proportion could partly be attributed to the adoption of workplace guidelines for the prevention of musculoskeletal injuries by the WHO in 2002 by the management of the Tarkwa Mines.
This prevalence is far lower compared to a cross-sectional study of 280 male underground gold miners in Ghana where the twelve-month prevalence was reported to be 67% (Bio et al., 2007). This could be attributed to the fact that this study encompassed all other MSDs while the study by Bio et al., only looked at Low back pain. The prevalence found in this study is lower compared to the finding of a study by Sarikaya et al. (2014) who established that the prevalence of musculoskeletal pain amongst Turkish coal miners was 78%. Similarly, the finding was lower with the results from a study on MSDs in Venezuelan among oil tanker crews that showed that the prevalence of MSDs in crews was 82% (Fernández, Jameson & Brito, 2014). The difference was that the Turkish and Venezuelan study used a sample size 782 mine workers and 600 mine workers respectively whilst the sample size of this current study was 180 respondents. This might have accounted for the low level of proportion with WMSS in this study.

The proportion of miners identified with WMSS is very good in this current study considering the dilapidating effect of musculoskeletal pain on work output. Where the work output of miners is low as a result of musculoskeletal pain, it decreases the overall productivity The proportion of WMSS obtained in this study was also lower than that of a study carried out in Turkey where 78% of coal miners had work related musculoskeletal symptoms in a cross sectional study (Sarikaya, 2007).

### 5.3.2 Body parts that are mostly affected by work-related musculoskeletal symptoms

From this study, most of the mine workers experienced musculoskeletal pain in the forearm (94.4%), upper arm (69.4%) arm and lower back (52.8%). The high proportion of WMSS of the forearm could be as a result of mineworkers having to carry heavy loads in a loader and also lift heavy weights. The job description of these miners mostly involved manual lifting that required the use of the forearm movements. This study found that the odds of developing work-related musculoskeletal symptoms among miners who lift objects weighing more than 25kg 1-5 times daily was higher compared to those who do not lift objects more than 25kg. This might have contributed to the pains experienced in the forearm since the muscle contract and relaxes during lifting and such movement can affect the forearm in most cases (Fernández, Jameson & Brito, 2014). Quite a number of the workers (52.8%) experienced lower back pain that interferes with the ability to work. Lower back pain has been ranked among the most common and difficult occupational health problems and is a major contributor to the high absenteeism rates in the mining industry (Dias, 2014). This is as a result of twisting and turning during tightening of bolts, lifting and pulling of objects by the Miners. These activities are routine and hence might have contributed to the pain the miners' experienced in their lower back (Okunribido et al., 2006). In order to reduce lower back pain, miners should reduce the weight they carry and there should be frequent job rotation. The finding is also consistent with the work of

Kunar et al. (2008) who assessed relationships of job hazards, lack of knowledge, alcohol use, health status and risk taking behavior to work injury of coal miners in india and reported lower back pain, forearm and upper arm as the major body parts with WMSS that interfere with their work.

This finding is also consistent with a study conducted in South Africa (Dias & Shutte, 2005), which found forearm and back injuries to be the majority among miners (rock drill operators and winch operators) at two South African mines. Furthermore, contrary to some previous studies (Dias, & Shutte, 2005; Sari et. al., 2004; Wiehagen, & Turin, 2004) that reported that the knee was the most affected joint after the back, the present study was not consistent with their findings. The differences could have risen due to sample size and duration of study. This current study used a period of 12 months to assess the musculoskeletal symptoms of miners whilst the other studies used a period of two years.

### 5.3.3 Factors influencing the risk of developing work-related musculoskeletal symptoms

From the study findings, some factors were identified to influence the risk of mineworkers developing musculoskeletal symptoms. The study found out that physical factors such as the weight carried by mineworkers influenced their risk of developing work-related musculoskeletal symptoms. It was realized that workers who lifted objects more than 25kg had an increased odd of developing work-related musculoskeletal symptoms compared to workers who did not lift weight more than 25kg. This is as a result of the impact of the heavy weight of these objects on the musculoskeletal system. They usually cause strain on worker's muscles. When the weight is heavier, there is a resultant strain on the muscles. This strain leads to muscle aches (Li, 2015).

Miners who do not operate machines that cause whole body vibration had reduced odds of developing work-related musculoskeletal symptoms compared to workers who operate machines that cause whole body vibration. Whole-body vibration affects tendons, muscles and joints, decreases sensitivity to specific body parts which may lead to injuries and fatigue to those parts of the body. Heavy equipment operators are exposed to Whole-Body Vibration (WBV) that can result in MSDs. Gallais (2008) also indicated that whole-body vibration contributes significantly to degeneration of the lumbar spine to which muscles and ligaments are attached resulting in pain at early stages of exposure. This eventually results in WMSS. Various authors have noted that the main risk factors associated with the operation of heavy equipment vibrations from jolts and shocks, repeated or continuous use of muscles such as lifting heavy objects (Jorgensen et al., 2007, Middleworth, 2016). Finally, a study done by Ghaffari et al. (2006) showed that whole body vibrations contribute to WMSS especially low back pain.

There was a significant association between job demand and development of work-related musculoskeletal symptoms. Miners with high job demand were more likely to develop work-related musculoskeletal symptoms compared to workers with low job support. The finding could be attributed to job rotation by the management of Tarkwa Mines as a best practice of job support. Job support have been found to reduce the cases of WMSS among production workers in highly repetitive jobs with heavy loads (Mathiassen, 2006).

This current study did not find psychosocial factors (job support and job strain) to be significantly associated with WMSS. Furthermore, the finding agreed with the finding of Eatough et al., (2012) who found out that Job demand and Job control were not significantly associated with the development of WMSS (Middleworth, 2016).

Individual factors (marital status and BMI) were not associated with the development of WMSS in this current study. The finding was not consistent with Bio et al., (2007) who found that mineworkers with a Body Mass Index (BMI) of over 23 had a higher prevalence developing WMSS particularly lower back pain. But this may be so because in their study most of the respondents were classified as obese and this might have contributed to the significance as compared to this current study. The individual findings in this study are in line with findings reported in similar studies such as Ghosh, Bhattacherjee & Chau, 2004; Paul & Maiti, 2007).

The findings for age was a bit surprising since old age has been reported to influence WMSS among workers (Nunes & Bush, 2015). This is so because as one's age increases, one is more likely to have weak tendons and bones and is more likely to develop WMSS compared to that of younger workers (Keir et al., 2011). This finding disagree with the finding of a study by Nunes & Bush (2015) and this could be attributed to the fact that in the Nunes & Bush (2015) study, the maximum age group was above 45 years whilst in this current study most of the respondents (33.9%) were between 32-38 years, a relatively younger group.

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# CHAPTER SIX

# CONCLUSION AND RECOMMENDATIONS

## 6.1 Conclusion

The study sought to assess the prevalence and risk factors of Work-related musculoskeletal symptoms among miners of Goldfields Ghana Limited (Tarkwa Mines). The proportion of miners that experienced work-related musculoskeletal symptoms of Goldfields Ghana Limited was low. The fore arm, upper arm and lower back were the body parts that most miners experienced the most musculoskeletal symptoms and discomfort that interfered with their ability to work. Factors found to influence work-related musculoskeletal symptoms were; working category, job demand, number of times lifting objects weighing >25kg daily, operating machines that cause whole body vibrations, and BMI were the factors found to be significantly associated with WMSS.

The findings of this study concludes that the proportion of work-related musculoskeletal symptoms among miners of Goldfields Ghana Limited is very high for the forearm, lower back and upper arm. The study therefore highlighted the need to improve on job support to help prevent miners from experiencing musculoskeletal symptoms.

## 6.2 Recommendations

It is recommended that an effective revision of the company's work plan must be done to ensure continuous job rotation. Doing this will lessen employees risk of experiencing work-related musculoskeletal Symptoms.

Further study should be carried out to determine the impact of Work-related Musculoskeletal Symptoms on the productivity of the Goldfields Ghana Limited.

There should be sensitization of workers on the dilapidating effect of musculoskeletal pain on the health of individuals and the need for early care when experiencing any form of musculoskeletal pain.

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# APPENDICES

## Appendix A: Participant's Consent form

**Title of study:** Risk factors associated with work-related musculoskeletal symptoms (WMSS) symptoms among mineworkers in goldfield Ghana (Tarkwa mines)

**Introduction**

**Researcher:** Gertrude Annan

**Department:** Biological, Environmental and Occupational Health (BEOH)

**Phone:** +233(0)242122346

**Email address:** manyeadoma@gmail.com

**Background of the study**

Mining has been characterized as one of the most hazardous occupations amongst major industrial activities. Despite regulations, automation and increased attention towards reducing risks through safety campaigns, the mining industry is still associated with higher rates of injuries compared with other industries. Mineworkers 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. As a result, my workers are often exposed to a high risk of musculoskeletal disorders (MSDs). I am undertaking a study on the risk factors associated with work-related musculoskeletal disorders among mining workers in Goldfields Ghana Limited. Consent will be sought from workers who have worked with the company for one year and more. Workers who meet the inclusion criteria will be served with a structured questionnaire, which will take about 15 minutes to complete, to solicit their views on the topic under study.

**Nature of study**

The study hopes to assess the risk factors associated with work-related musculoskeletal disorder among mineworkers in Goldfields Ghana. It is a quantitative study that uses a structured questionnaire to solicit information from the respondents. It will require about 15 minutes of the respondents time to complete.

**Duration**

I will require 15 minutes of your time.

**Potential risks/benefits**

The study will not cause any discomfort to participants. It is hoped that results obtained for this study will be used by policymakers in developing effective injury prevention programs in the mining industry, Ghana or to enforce existing ones with the objective of better improving the safety and wellbeing of mine workers.

**Privacy/Confidentiality**

I would like to assure you that whatever information provided will be handled with strict confidentiality and will be used purely for research purposes. Your data will not be shared with anybody who is not part of the research team. Data analysis will be done at the aggregate level to ensure anonymity. Your identity will not be disclosed in the material that will be published.

**Voluntary withdrawal and compensation**

Participation in this study is voluntary and participants can choose not to answer any particular question or all questions. You are at liberty to withdraw from the study at any time without prejudice from the study team. However, it is encouraged that you participate since your opinion is important in determining the outcome of the study. You will not be provided with any reward/compensation to respond to the questionnaire.

**Provision of information and consent form**

A copy of the information sheet will be given to you after it has been signed or thumb-printed to take home.

**Ethical Approval**

The study will be reviewed and approved by Goldfields Ghana (Tarkwa mine) Ethical Review Committee. This committee is there to ensure that participants in researches are protected from harm and their rights are respected.

**Before taking Consent**

Do you have any questions you wish to ask about the study? Yes |____| No |____|

If yes, please, indicate the questions below

………………………………………………………………………………………..……………

……………………………………………………………………………

In case you have any questions on the study later please, do not hesitate to contact **Gertrude Annan**, Department of Biological, Environmental and Occupational Health, School of Public Health, University of Ghana. (Tel: 0242122346) Email: manyeadoma@gmail.com.

**Consent Form**

I……………………………………., declare that the purpose of the study has been thoroughly explained to me in the English language/Ga/Twi and I have understood. I hereby agree to answer the questions. I understand that it is voluntary and can opt-out at any time.

Signature…………………………. Date……………………………

Thumbprint

**Witness Statement**

I declare that I was present while the benefits and procedures were read to the participants and all questions were answered and the participant has agreed to take part in the study

Witness signature………………………… Date ……………………

**Interviewer's Statement**

I, the undersigned, have explained this consent form to the subject in the English language/Ga/Twi that he/she understands the purpose of the study, procedures to be followed as well as risks and benefits involved. The subject has freely agreed to participate in the study.

Interviewer's signature…………………………

Date…………………………….. Address……………………………

**School of Public Health**

**College of Health Sciences**

**University of Ghana**

**Appendix B: Research questionnaire**

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 musculoskeletal symptoms at your workplace. 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

**SOCIO-DEMOGRAPHIC DATA**

**1. Year of birth or Age …………………………**

**2. Sex**

a. Male b. Female

**3. What is your current marital status?**

a. Married b. cohabiting c. Separated d. Divorced e. Widowed f. Never married

**4. What is the highest level of education you have completed? (Circle the letter)**

a. Have not been to school before b. JSS/Middle school/primary school

c. SSS/Secondary school/vocational or technical training

d. Polytechnic/teacher training e. University

**5. Height**………………………metres/centimetres

**6. Weight**……………………kilogrammes

**5. What is your department?** ………………………………………………………

**6. What position/rank do you hold in this department?** ………………………………

**7. Length of service in the department…………………………………………………**

**8. How many dependents do you have? ……………………………………………**

**9. Are you currently in any of the following work situations? Record how long you have been in this situation (for example, 3 weeks or 5 months or 7 years).**

| | Yes | How long have you been in this situation? | | |
|---|---|---|---|---|
| | | Week | month | Year |
| a. Full-time worker | | | | |
| b. Contract worker | | | | |

**This section of the questionnaire inquiries about your employment and Working conditions. Please answer with a check or a circle the response that best describe your circumstances**

**ORGANISATIONAL WORK FACTORS (Work schedule)**

**10. Working schedule**

a. Days only
b. Night only
c. Day and night work

**11. Number of hours worked per week**

a. ≤ 40 hrs

b. 41-49 hrs

c. ≥50 hrs

**12. Number of days worked per week**

a. 1-5

b. 6-7

**13. Number of hours worked per day**

a. ≤8hrs

b. ≥12 hrs

**14. Work schedule in the last 3 months**

| | MARCH | APRIL | MAY |
|---|---|---|---|
| Hours of work/day | | | |
| Hours of work/week | | | |
| Days of work /month | | | |

**15. How many breaks do you take in a typical working day?**

a. None

b. Once

c. Twice

d. More than 3 times

**16. PSYCHOSOCIAL WORK FACTORS**

**(Please indicate the degree to which you agree to the following statements.)**

| | Strongly disagree (1) | Disagree (2) | Agree (3) | Strongly Agree (4) |
|---|---|---|---|---|
| 1.My job requires that I learn new things | | | | |
| 2. My job involves a lot of repetitive work | | | | |

| | | | | |
|---|---|---|---|---|
| 3.My job requires me to be creative | | | | |
| 4. My job allows me to make a lot of decision on my own | | | | |
| 5. My job requires a high level of skill | | | | |
| 6.I am allowed to decide how to do my work | | | | |
| 7.I get to do a variety of things on my job | | | | |
| 8.I have a lot to say about what happens on my job | | | | |
| 9. I have an opportunity to develop my special ability | | | | |
| 10.My job requires working very fast | | | | |
| 11.My job requires working very hard | | | | |
| 12.My job requires lots of physical effort | | | | |
| 13.I am asked to do an excessive amount of work | | | | |
| 14. I have enough time to get the job done | | | | |
| 15.I am free from conflicting demands others make | | | | |
| 16.If work gets difficult, my colleagues will help me | | | | |
| 17. People I work with are getting the job done | | | | |
| 18. My supervisor pays attention to what I am saying | | | | |

**PHYSICAL WORK FACTORS**

**17. Do you handle object that causes your hand to vibrate**

a. Yes

b. No

**18. Mention the object/machine………**

a. Hand drills

b. Chipping machine

c. Riveting guns

d. Hand-held grinders, scrapers

**19. Do you operate machines that cause whole-body vibration? Whole body vibration**

a. Yes

b. No

**20. Which instrument**……………

a. Dump trucks

b. Angle grinders

c. Dozers

d. Loaders

e. Excavators

f. Crushers

**21. On a typical work day how many times do you lift an object weighing more than 25kg**

a. None
b. 1 to 5 times
c. >5 times

**22. On a typical workday how many times do you lift an object weighing less than 25kg**

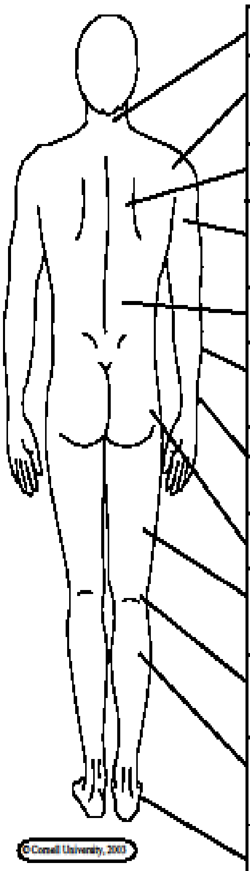
a. None
b. 1 to 5 times
c. >5 times

**23. How many hours per day do you work standing…..**

a) Less than an hour
b) 1 to 4 hours
c) 5 to 8 hours
d) More than 9 hours

## 24. Cornell musculoskeletal discomfort questionnaires

The diagram below shows the approximate position of the body parts referred to in the questionnaire. Please answer by marking the appropriate box.




| | | During the last work week how often did you experience ache, pain, discomfort in: | | | | | If you experienced ache, pain, discomfort, how uncomfortable was this? | | | If you experienced ache, pain, discomfort, did this interfere with your ability to work? | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Never | 1-2 times last week | 3-4 times last week | Once every day | Several times every day | Slightly uncomfortable | Moderately uncomfortable | Very uncomfortable | Not at all | Slightly interfered | Substantially interfered |
| Neck | | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Shoulder | (Right) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| | (Left) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Upper Back | | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Upper Arm | (Right) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| | (Left) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Lower Back | | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Forearm | (Right) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| | (Left) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Wrist | (Right) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| | (Left) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Hip/Buttocks | | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Thigh | (Right) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| | (Left) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Knee | (Right) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| | (Left) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Lower Leg | (Right) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| | (Left) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Foot | (Right) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| | (Left) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |