KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

COLLEGE OF HEALTH SCIENCES

SCHOOL OF MEDICAL SCIENCES

DEPARTMENT OF COMMUNITY HEALTH

Topic:

KNOWLEDGE OF MINE WORKERS ON MINE RELATED HAZARDS AND PREVENTION: A CASE STUDY OF MINE WORKERS AT ARCELORMITTAL MINING COMPANY IN YEKAPA NIMBA COUNTY REPUBLIC OF LIBERIA.

By

Alexander Mingei Nakamu Jr.

November , 2016

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A Thesis submitted to the Department of Community Health,

College of Health Sciences

In partial fulfillment of the requirements for the degree of

Master of Science (Disability, Rehabilitation and Development)

November, 2016

DECLARATION

I hereby declare that this submission is my own work except for references of the peoples' I have cited, which are duly acknowledged; towards the award of MSc Disability, Rehabilitation and Development and that, to the best of my knowledge. It is my own investigation which contain no previously published materials by another person, nor material which has been accepted for the award of any other degree of the University.

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DEDICATION

This work is dedicated firstly to God Almighty, and secondly to my mother Mrs. Elaine Nahn Nakamu.

ACKNOWLEDGMENT

I want to extend my thanks and appreciation to God almighty for a successfully completion of my Master Degree study. To Him all credit of the success of my life is owe.

Great applaud goes to Arcelomittal-Liberia for providing me the opportunity to do my study. I am grateful to my supervisor in person of Dr. Wisdom Kwadwo Mprah, who tirelessly give me all the time and support I needed for my entire research work. I sincerely appreciate his prompt responses, guidance and criticisms, which added value to the work. To him countless thankfulness and I pray that God Almighty will replenish his efforts.

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Finally, to all my friends, family members, love one for assisting me in different ways, time and space will not permit me to mention names but your contributions are all appreciated. God richly bless you all. Amen.

ABBREVIATIONS

WHO- World Health Organization

HSE- Health Safety Executive

DHHS- Department of Health and Human Services-US

BLS- Bureaus of Labor Statistics

MOHSW-L- Ministry of Health and Social Welfare-Liberia

NIOSH- National Institute of Occupational Safety and Health

SSUM- Small Scale Underground Mining

MSHA- Mine Safety and Health Administration

ILO- International Labor Organization

KNUST- Kwame Nkrumah University of Science and Technology

PPE- Personal Protective Equipment

ABSTRACT

Background: Knowledge of workers on work-related injuries is crucial because such injuries have the potential to cause disability. Knowledge on the risk factors is crucial in preventing long term disablement that has the tendency to disrupt workers' quality of life and boost the productivity of mining companies.

Objective: To ascertain the level of knowledge of workers of Arcelormittal Mining Company on work related hazards that have the potential to cause disability.

Methods: A cross-sectional design using quantitative method, was utilized in this study. Purposive sampling technique was used to select a total of 202 workers, consisting of 7 managers, 20 supervisors, 51 miners and 124 ground workers for the study. These respondents were chosen to ensure that the sample is representative of the entire workforce. A questionnaire with close-ended items was used to collect information from the participants.

Results: A mean age of 34.73 years, suggests the company has a mainly youthful workforce. The vast majority of workers were ground workers with miners constituting a fourth of all workers. Majority of workers had fair knowledge of the inherent dangers associated with mining. The vast majority of respondents were privy to the obvious dangers posed by specific elements within the mine. Supervisors and ground workers tended to be more knowledgeable on specific safety and preventive measures compared to miners. Almost all respondents were privy to general emergency actions. While most workers were knowledgeable on the various protective gear, a sizable number had little knowledge of the bump cap. Miners tended to have the highest frequency of usage of protective gear compared to all other workers.

Conclusion: The greater effort to eradicate accidents and injuries in mining hugely depends on proper understanding of information dissemination on hazards in the mines.

Keywords: Arcelormittal mining company, safety awareness and prevention, danger, worker knowledge safety measures.

CHAPTER ONE

INTRODUCTION

1.1 Background

Around the world, more than a billion people live with disabilities, the vast majority in low and middle-income countries. A significant proportion of these disabilities are caused by direct injuries, including those that result from working in mines and industries (WHO, 2015). Global and regional estimates of injury-specific cause of disability are lacking. However, estimates from some countries suggest that up to one quarter of disabilities may result from direct injuries (WHO, 2015). Examples of direct injury-related impairments that may lead to disabilities include physical and/or cognitive limitations due to neurotrauma, partial or complete amputation of limbs, physical limb deformation resulting in mobility impairments, psychological trauma, and sensory disabilities such as blindness and deafness (WHO, 2015).

Despite increased safety measures and decreased death rates, mining still receives national attention as a dangerous industry. Even though research and new practices continue to reduce the dangers of the mining industry, its injury-related reputation is somewhat higher compared to other industries (WHO, 2015). Latest estimates show that annually over 600,000 mine workers are injured in workplace accidents and a further 500,000 workers suffer new cases of ill health caused by working in the mine (Health Safety Executive, 2015).In 2006, there were 3021 non-fatal injuries among coal miners occurring at a rate of 3.3 injuries per 100 full time equivalent employees (US Department of Health and Human Services [DHHS], 2008). The Bureau of Labor Statistics [BLS]

(2007) posited that employees in coal mining are more likely to be killed or to sustain an injury or illness than workers in other industries. These injuries are also likely to be severer. In fact, the rate of non-fatal injuries and illnesses in coal mining in 2005 was 11% higher than total in the mining industry (BLS, 2007).

Fatigue has been associated directly with an increased risk of injury and near-miss accident in workers (Lilley et. al., 2002; White and Bestwisk 2003; Philip 2005). Long working hours and restricted sleep are both factors associated with increased risk of injury at work place. Also, in most industrious areas the safety rules to some extent are not adequately explained to workers thereby giving rise to serious accidents (Burgess-Limerick et al 2006). At the national level increased mine related injuries have the potential to increase the cost of medical services as these injuries require more specialized services, straining an already burdened health care system in Liberia (Ministry of Health and social Welfare-Liberia, 2014).

Knowledge of workers on work-related injuries that has the potential to cause disability is crucial in preventing long term disablement that has the tendency to disrupt workers' quality of life and boost the productivity of mining companies with the potential to better Liberia's economy in the long term scenario.

1.2 Problem Statement

Each year significant number of workers are injured or made ill by mine related work. Apart from the financial costs from these cases (for example, in terms of lost production and healthcare costs), these cases impose human costs. The human cost of mine related injuries is massive due to the often serious nature of the injuries. These injuries usually require long term rehabilitation and do not only affect the quality of life of the injured worker but that of the immediate family as well. Mostly, the immediate family assumes the role of caregiver at home, putting their jobs on hold. At the company level, the loss of manpower due to severe mine injuries implies that companies would have to employ the services of stand-in staff, further increasing the cost of production since these new staff might require some training before engagement. Furthermore, huge financial compensation packages to injured workers have the potential to hamper the operations of affected companies in the long term (HSE, 2015).

There are many factors that contribute to injury in the mining industry. Prime among these factors is the lack of knowledge on the part of workers of the dangers associated with their work. Fatigue, inattentiveness, lack of adherence to safety rules at workplaces are also major causes of injury that lead to disability in mines. More so, most employers are interested in high productivity and profit thereby paying little attention to enforcing safety measures to ensure safe working environment.
In spite of the importance of workers' knowledge on dangers associated with mine work in preventing injuries that could lead to disabilities, little research has been done on this issue.
Therefore, this study fills the knowledge gap by exploring the level of knowledge of Arcelormittal Company workers' on the dangers associated with their job. The overall aim is to assist both employers and employees to adopt measures to prevent conditions that cause disability.

1.3 Research Questions

1. What is the level of awareness of mine workers in Arcelormittal Company on the dangers associated with working in a mining company?

2. What is the level of knowledge of workers in Arcelormittal Company on general safety measures to prevent work-related practices that have the potential to cause disability in mining company?

3. What are the measures being taken by Arcelormittal mining company to improve the safety of its workers?

1.4 General Objective

To ascertain the level of knowledge of workers of Arcelormittal Mining Company on work related hazards that have the potential to cause disability.

1.5 The specific objectives are:

1. To assess workers' level of awareness of the dangers associated with working in Arcelormittal Company.
2. To assess the level of knowledge of workers on general safety measures to prevent work-related injuries that have the potential to cause disability.
3. To ascertain the measures being employed by Arcelormittal Mining Company to improve safety.

1.6 Justification

Considering the long term implications of injuries related to the mining industry, emphasizing the need for workers to strictly adhere to safety measures is of utmost importance. The study therefore serves as a timely reminder of the dangers associated with mining and will be useful to miners, employers, policy makers and advocates in that it will provide data that will inform policy-making on the safety of mine workers. Specifically, advocacy groups could point to how relevant knowledge on safety contributes to lesser injuries to miners and its overall benefit to the company.

For the employer (company as a whole) the study will bring to the fore which area of safety training is lacking as well as the additional safety equipment that is needed to maximize workers' safety. The safety of these workers will surely enhance the financial fortunes of the company and reduce the incidence of severe injuries.

1.7 Conclusion

The preceding section highlighted the essence of the study and provided a thorough theoretical perspective of the study. It described the desired objectives and gives justification to subsequent approaches and methods that will be utilized in the study.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter reviews literature on the subject under study. The literature was reviewed under the following themes: mining as an occupation, hazards in mining industry, work-related injuries in the mining sector, and currents trends in mine-related safety, injury rates in mines and associated morbidity and mine work policies to enhance safety and to prevent injuries. The conceptual framework for the study has also been described in this chapter.

2.1 Hazards in the mining industry

Mining is an occupation that involves the extraction of minerals resources from the earth. It is undertaken in a network of shafts and tunnels which have to be designed according to geological information obtained from drilling. Shafts in the mines have to be designed to handle the required volume of air to produce an environment that is acceptable by world standards and to handle the total tonnage of mined minerals, materials and men (Gostudy.net, 2016). Mining as a profession is therefore unique and brings together different practitioners. The practitioners in the mining industry include mining engineers, electrical and mechanical engineers, geologists, matriculants, mining surveyors, miners, underground workers and supervisors.

All these professionals have specific functions in the mine to make it safe. For example, the mining engineer work is responsible for designing the best mining method for any specific ore-body. He makes extensive use of the latest technology in the computer field to design the safest and most economical mining method. The electrical and mechanical engineers ensure the effectiveness of the design, construction and the maintenance of machinery and equipment in the mine, while the geologist draws conclusions from cores obtained from the mine. The geologist uses sensitive instruments and applies principles such as electromagnetism, shock waves and radioactivity to detect the presence of certain minerals. The geologist may also use observations made by sensory devices scanning the earth from an orbiting satellite (Gostudy.net, 2016). The mining surveyor is the specialist on the mine and he or she is responsible for that measurement, representation and management of data associated with mining operation. He or she is also in charge of marking out, measuring and maintaining direction of all surface and underground workings on the mining site (Jankani, 2016). In addition, the surveyor conducts surveys at surface and subsurface mine workings, tunnels and subway sites, and underground storage facilities to control the direction and extent of mining.

Matriculants are specialists from different backgrounds of science, who are trained to work in whatever capacity they are hired for. They worked to safeguard the mine for conducive working environment and productive extraction of minerals. They rely on modern sophisticated devices to gather all the information required for mine operation (Crystalrugged.com, 2016).

Mining is an ancient occupation, long recognized as being arduous exposing workers to injuries and diseases (World Coal Institute, 2007). Biswas (2001) reaffirmed that mining has been accepted the world over as a hazardous profession, which involves a continuous struggle by the work force with unpredictable forces of nature.

Miners face a plethora of dangers working in what often amount to cramped, unsafe facilities. The threat of injury is almost constant, and miners are often being injured from falling objects, equipment, and roof collapse (Hansen, 1989). Despite improvements of working conditions in the mining industry in many developed countries during the past decades, work-related injuries due to hard physical labor, frequent lifting and carrying heavy weights, static work, exposure to vibrations, climatic influences, noise, and dust still pose obvious risks for mining workers (Dhalback, 1991). It has been found that traumatic injury remains a significant problem in the mining sector and ranges from the trivial to the fatal (Dhalback, 1991). Common causes of fatal injury include rock fall, fires, explosions, mobile equipment accidents, falls from height, entrapment and electrocution (Dhalback, 1991).

Direct mine injuries are a major contributor to the burden of occupational dangers in the mining sector in many developed countries (Hansen, 1989; Frone, 1998). Similarly, evidence from several studies indicated that these injuries contribute to occupational disability and to the overall disease burden in the mining sector (China Labor Bulletin, 2007; World Coal Institute, 2007; Harrell, 1990, Frone, 1998). Harrell (1990) argued that occupational injuries within mines can be associated with two major causes. The first is related to the characteristics of the mine environment and work-practices and the second cause, which is more controversial, involves the characteristics of the individual. The individual factors are personality traits and psychological state, whereas situational factors depend on the physical environment, task environment, organizational and cultural environment and the immediate psychological environment (Tien, 2005).

Major health risks encountered in mining include airborne pollutants such as silica dust and coal dust, noise, heat and vibration (Partha Das Sharma 2009). Dhalback (1991) mentioned other significant health risks as chemical risks, which are not related to underground air pollutants or gases, skin disorders, ergonomic stresses, ionizing radiation and, in the diamond sector, decompression illness associated with diving. In addition to accidents, musculoskeletal disorders make up a substantial part of non-fatal injuries and illnesses in mining work (Dhalback). In contrast, Mutemeri (2002) stated that, although there are obvious workplace hazards associated with working in a mine, these are not the only risks associated with mining activities. Simply living within proximity of a mine can cause a variety of health concerns, and both types of mining (deep and surface) pose their own set of problems.

According to Donoghue, (2004), hazardous conditions in the mine can be classified into five groups, namely, physical hazards, chemical hazards, biological hazards, agronomical hazards, and psychosocial hazards. These hazardous conditions are described according to how they negatively affect workers in the mine.

2.1.1 Physical hazards

Physical hazards also known as traumatic injury remains a significant problem and ranges from the trivial to the fatal. Common causes of fatal injury include rock fall, fires, explosions, mobile equipment accidents, falls from height, entrapment and electrocution National Institute of occupational Safety and Health (NIOSH, 1995). Less common but recognized causes of fatal injury include flooding of underground workings, wet-fill release from collapsed bulkheads and air blast from block caving failure (NOISH, 2000; Mineral Council of Australia, 2002). Evidence suggests that significant numbers of these mine-related injuries are associated with falls, which are the leading cause of occupational injuries in the mining industry and constitute a substantial proportion of permanent and temporary disabilities (Hansen, 1989; Frone, 1998).

2.1.2 Chemical hazards

Silica has been the most hazardous chemical in mining, causing silicosis. There are also other chemicals like mercury, coal dust, asbestos, nickel compounds, hydrofluoric acid, hydrogen sulfide gas, and xanthate reagent which are perilous and their effect is lethal to human beings. Santraet. al., (2013) also identified arsenic as another potential carcinogenic chemical, which causes many infections including malignant arsenical skin lesions, Bowen's disease, basal cell carcinoma and melanoma, or squamous cell carcinoma. Aside from carcinoma and melanoma, chronic arsenic exposure leads to respiratory disease, gastrointestinal disorder, liver malfunction, nervous system disorder, hematological disease like anemia, leucopoenia and thrombocytopenia, diabetes and severe cardiovascular malfunction (Santra, et al., 2013).

2.1.3 Biological hazards

Biological hazards are associated with organisms. The risk of tropical diseases, such as malaria and dengue fever is substantial at some remote mining locations are common. Leptospirosis and ankylostomiasis were common in mines, but eradication of rats and improved sanitation has controlled these hazards effectively in the developed world.

2.1.4 Ergonomic hazards

Even though mine has been hugely mechanized, some operations are done without the use of machines. Manual handling as well as mining using physical strength without the use of machine causes ergonomic hazards (NOISH, 2000). Wen Yi et al., (2016) mentioned high humidity and heat stress as major ergonomic hazards that are overlooked, therefore, suggesting that, eradication will heavily depend on newly designed uniforms that would reduce thermoregulatory and cardiovascular strain and improved thermal comfort while working in a hot and humid environment.

2.1.5 Psychosocial hazards

Many are of the thinking that ingesting stimulant substances enhance the performance of mine workers. This thinking has increased drug and alcohol consumption among mine workers and it is becoming difficult to handle (Donoghue, 2004).

2.2 Injury rates in mines and associated morbidity

The hazardous nature of mine operations can be determined from national statistics on mine accident and injuries. For example, the number of fatalities and serious bodily injuries in 2004 and 2005 in Indian coal mines were 96, 120 and 991, 1125, respectively (Stanton, 1995). The fatality and serious bodily injury rates per 1000 persons employed for the years 2004 and 2005 are 0.24, 0.30 and 2.45, 2.78, respectively (Directorate General of Mines Safety 2005).

Incidents resulting in multiple fatal injuries are much more prevalent in mining than in other industries. In coal mining, for example, 72.1 percent of the cases were part of multiple fatal injury incidents, compared with 26.7 percent in mining overall, and 8.6 percent for all industries (Directorate General of Mines Safety 2005). From 1900 to 1945, there were more than 1,000 fatal injuries every year in mining alone, according to the U.S. Department of Labor, Mine Safety and Health Administration (2010).

Although the total number of mine worker fatalities as well as fatality incidence rates has trended downwards during the past 20 years, the proportion of these accidents involving mine machinery and mobile equipment has consistently been significant (Kecojevic, Komljenovic, Groves, & Radomsky, 2007). The fatal injury rate for mining was more than five times higher than the figure for other industries (3.6 fatal injuries per 100,000 full-time workers) (Venem, Shutske, and Gilbert, 2006). Similarly, Schiffbauer (2005) stated that incidents resulting in multiple fatal injuries are much more prevalent in mining than in other industries. In total, there were 172 fatal work injuries in the mining industry during 2010 injuries report. This represents a 72.0 percent increase from the 100 fatal injuries reported in 2009. The fatal injury rate rose to 19.8 per 100,000 equivalent full-time workers in 2010, up from 12.4 in 2009 (Grayson, Layne, Althouse, & Klishis, 1992). In addition to the fatal work injuries, there were 15,500 recordable non-fatal injuries and illnesses in the mining industry during 2010, a rate of 2.3 incidents per 100 full time workers (Schiffbauer 2005).

Researchers at the National Institute for Occupational Safety and Health (NIOSH) have been concerned with the interaction of workers and machinery and with the number of severe accidents classified as struck-by or caught-in (Burgess-Limerick & Steiner, 2006; Ruff, 2007; Schiffbauer, 2005; Venem, Shutske, & Gilbert, 2006). These accidents include workers entangled in rotating machinery, struck by moving machine components or run over by mobile equipment of mining workers (Feuerstein et al., 1988).

2.3 Trends in mine related safety

Improved safety at the workplace, both through voluntary efforts and legislation, has been an important component of promoting occupational health and preventing injuries. Early research in the field tended to treat safety primarily as a technical problem that could be 'engineered out 'through improved design of workplace settings (Pidgeon 1991; Donald and Canter 1993; Bahn, (2013). Uttal's, (1983) definition of safety culture captures most of its essentials: 'Shared values (what is important) and beliefs (how things work) that interact with an organization's structures and control systems to produce behavioral norms (the way we do things around here).

Bate (1992) and Thompson et al. (1996) suggested at least two ways of treating safety culture as something an organization is (the beliefs, attitudes and values of its members regarding the pursuit of safety), and as something that an organization has (the structures, practices, controls and policies designed to enhance safety). Both are essential for achieving an effective safety culture. However, the latter is easier to manipulate than the former (Hofstede 1994).

More recently, it is becoming widely accepted that technical approaches alone are inadequate to reduce accident rates to desired levels. That is, even when the purely technical problems associated with work settings are addressed, unacceptably high accident rates often persist (Pidgeon 1991, Reason 1997, Maiti and Dasgupta 2003). In a study by Sanders et.al (1998) to determine the contribution of system factors in the occurrence of underground injury accidents and safety in mine related works, the findings revealed that **i**n the absence of frequent bad events, the best way to induce and then sustain a state of intelligent and respectful wariness is to gather the right kinds of data. This means creating a safety information system that collects, analyses and disseminates information from incidents and near misses, as well as from regular proactive checks on the system's vital signs. The authors further explained that all of these activities can be said to make up an informed culture one in which those who manage and operate the system have current knowledge about the human, technical, organizational and environmental factors that determine the safety of the system as a whole (Sanders et.al 1998).

Perhaps the most critical distinction between individual and organizational accidents lies in the quantity, quality and variety of the defenses, barriers and safeguards that protect people and assets from the local operational hazards. Individual accidents occur in circumstances where the hazards are close to people and the defenses are limited or nonexistent (Cawley, 2003; Daling, 1983).

When mining started on an industrial scale in the 1880s, miners faced very high levels of risk to both safety and health. Over the years, the safety performance of mines improved, but not at the same rate as at in other major mining countries such as Australia, Canada and the USA (Mining Qualification Authority, 1995). The Commission of Inquiry into Mine Safety and Health (1995) of Australia, Canada and the USA, concluded on the basis of a number of studies that exposures to dust in mining had remained unchanged for 50 years. The Commission attributed this to absence of systemic approaches to controlling respiratory disease**.** In recent years, changes in legislation, better appreciation of the relationship between silica exposure, and commitments made by stakeholders in industry have resulted in fresh efforts to reduce health and safety risks (Joy, 2004). However, comprehensive initiatives to control health exposures are still new and in development. Since exposure data for airborne pollutants and noise indicate that risks to health are serious, they are likely to remain so until effective control strategies are implemented across the sector (Joy, 2004).

According to Minerals Council of Australia, (2004 and 2005), some of the interventions that have over the years contributed to reducing safety risk levels include standards for explosives used in mining, administrative control of explosives, underground stone-dusting in coal mines, flameproofing of equipment, improved cap lamp technology and improved ventilation systems.

However, McLaughlin (2006) argued that, although health risks can be avoided by implementing controls at source in the work environment, designing such controls for mining environments presents considerable challenges because dust and noise are generated by mining itself. According to Tien (2005), approaches to dust monitoring delay the recognition of the severity of the risks posed by airborne pollutants.

Guidelines on addressing airborne pollutants emphasize the importance of identifying and characterizing all sources of airborne dust, both primary and secondary, and properly integrating control interventions into procedures for choosing and maintaining equipment, and into the daily work cycle (Tien, 2005). While significant uncertainties remain in controlling dust exposures and maintaining the effectiveness of controls, the use of appropriate personal protective equipment (PPE) is important (United States Department of Labor, 2007).

Burgess-Limerick et al., (2006) emphasized that, in recent years, in the United States, legal rules for verifying dust control plans in coal mines have been developed. At the operational level, it is expected that the following will be checked before the start of a shift: water pressures and water flow to dust suppression sprays on continuous miners; air quality and air velocity at the locations where machinery operates; dust collectors on drills and other equipment; and any other controls specified in mine ventilation plans. Should controls be found wanting, production must be halted until they are properly.

At the Mine Health and Safety Summit of 2003, the tripartite stakeholders in mining agreed to target and milestones, which are aimed at addressing the major health and safety concerns of the sector. The milestones are considered to be the intermediate steps to achieving targets of zero fatalities and injuries, silicosis elimination and the elimination of noise-induced hearing loss.

Current trends in the available data indicate that the sector is not achieving the level of improvement needed to reach the milestones (United States Department of Labor, (2007). McLaughlin, (2006). However, significant resources have been galvanized, for example, to share information, identify helpful existing technologies, develop new technologies, support technology transfer, closely monitor trends, and understand the role of leadership which bode well for the future (United States Department of Labor, 2007).

2.4 Mine work policies to enhance safety

Historically, industrial accidents have been regarded as a tragic but unavoidable. Nowhere is this more apparent than in bituminous coal mining, which traditionally ranks first in accident frequency and severity rates among U.S. industries (Lewis-Beck et. al, and Wei et al., 2016, 1980). Attempts to improve this situation through federal legislation have occurred at various times in the mining industry. Inspection of coal mines by the federal government began with the passage of the Coal Mines Inspection and Investigation Act of 1941. This Act provided right of entry into coal mines for federal inspectors and mandatory reporting of injuries and related information Poplin et al., (2007).

However, the Act did not give the Bureau of Mines enforcement powers over safety. The Bureau, after inspecting a mine, could merely make recommendations (Poplin et al., 2007). Additional legislations were enacted in 1952 and 1966. The 1952 (Act 6) provided for annual mine inspections for large underground mines to determine if safety standards were being observed. The Bureau of Mines had authority to order corrections to observed deficiencies or to close a violating mine (Lewis-Beck et. al, and Wei et al., 2016, 1980). Surface mines and smaller underground mines (those employing fewer than fifteen workers) were exempt from the law. The 1966 (Act7) amended the 1952 law to cover all underground mines, regardless of size (Tien, 2005).

The Coal Mine Health and Safety Act of 1969 was later enacted to cater for the limitations of the earlier laws and legislations on the mine policies to enhance safety (Verma and Chaudhari, 2016).Lewis-Beck et al (1980) stated that, in common with other safety legislation of this period, the 1969 Act brought surface mines under federal regulation and clearly broadened the scope of the law. Unlike earlier laws, the 1969 Act covered all types of safety issues, from ordinary accidents to major disasters, and included health hazards attributable to coal mining such as disasters and health hazards attributable to coal mining, for example, coal workers' pneumoconiosis or black lung.

In 1977, Congress passed the Federal Mine Safety and Health Act (Mine Act) with the goals of consolidating existing regulations on mine safety and health, improving compliance, and keeping pace with innovations in the mining industry (The Minerals Council of Australia, 2002). Mine Safety and Health administration (MSHA) was created in 1978 to administer the provisions of the Act and to oversee mine safety and health. According to the Mine Act, “The first priority and concern of all in the coal or metal and nonmetal mining industry must be the health and safety of its most precious resource the miner (Chinamining.org, 2006).

International Labor Organization (ILO) and WHO established in 1997 the ILO/WHO Global Program for the Elimination of Silicosis. This was identified as a priority area for action in occupational health, obliging countries to place it high on their agenda. The objective was to reduce the incidence of silicosis drastically by 2015, and have silicosis as a public health problem eliminated by 2030. It was believed that the experience gained would provide a prevention model for other pneumoconiosis and a proven system to manage exposure to mineral dusts (McLaughlin, 2006). This goal was re-affirmed in 2003 at the 13th Session of the ILO/WHO Joint Committee on Occupational Health, which strongly recommended that special attention should be paid to the elimination of silicosis and asbestos-related diseases in future ILO/WHO co-operation (Johnson, 2006).

2.5 Health, safety and labor in Liberia mine

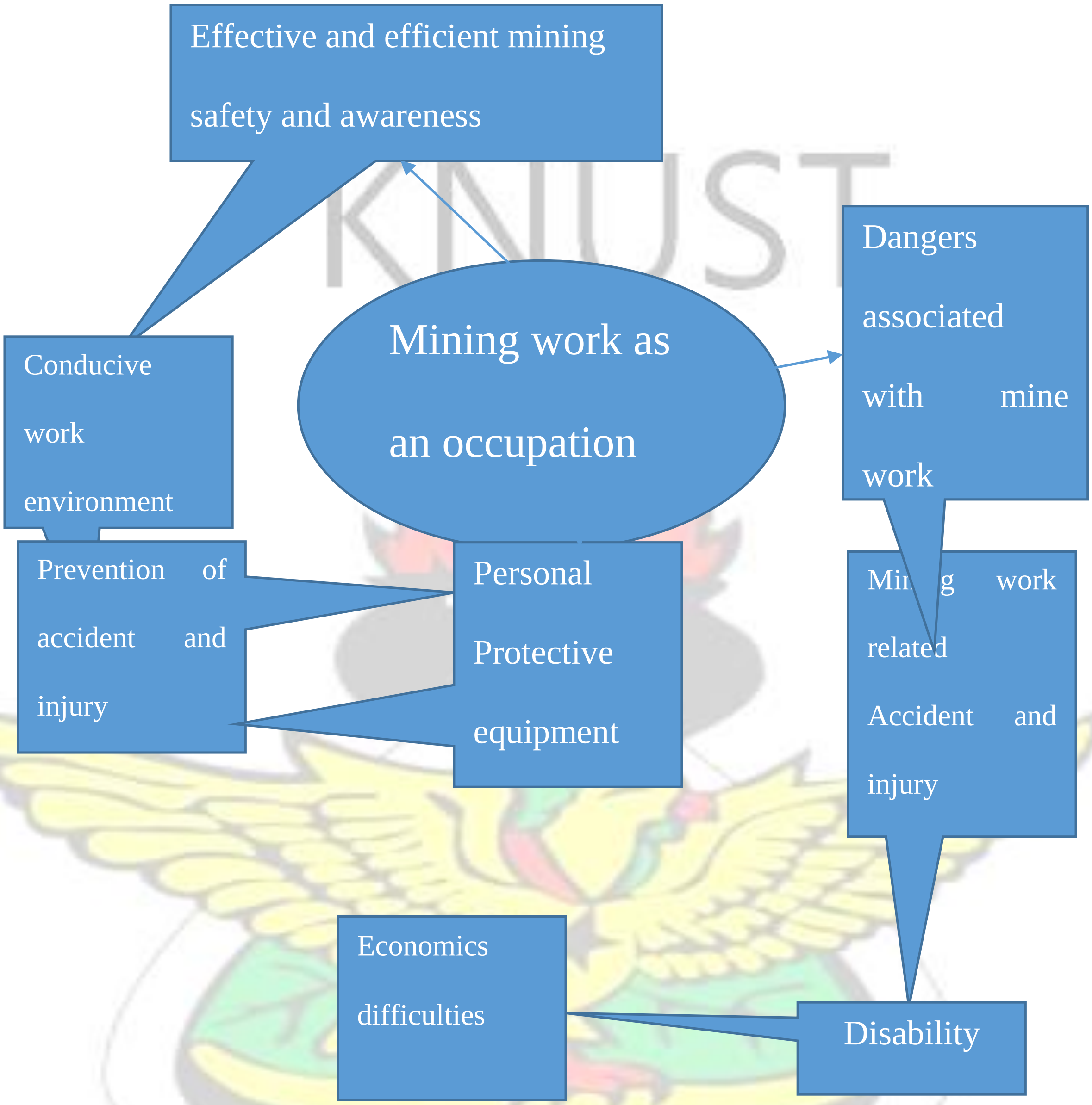
From the Liberian experience of the civil war, health and safety have become the focus of its government. As it had been in other countries, there are legal instruments to regulate mining activities and to protect both the mining industry and workers. In 2000, through the ministry of Land, Mines and energy, a law to protect workers and residents of the mining community as well as the environment was passed. The law, Act 2000, states that, "every mining right holder must ensure all measures to mitigate or eliminate risk of danger to the worker and the community that may be cause by mine" (Ministry of Lands Mine and Energy-Liberia [MLME] 2000 Act, p. 2).

The Act also requires that mining right holders should ensure realistic prevention, corrective and restorative action to limit pollution, contamination or environmental damage caused by the mine or its development. An environmental impact assessment study must be submitted before a class A or class B mining licenses will be granted. In addition, the Act noted that the study must immensely focus on the adverse effect the mining may have on the nearby community (Mondaq, 2016).

2.6 Conceptual framework.

Figure 1 below presents the conceptual framework for the study. It describes factors that could expose miners to accidents and injuries. Mining as a profession has been an ancient occupation, long recognized as arduous and liable to accidents, injuries and diseases. Miners need to be extremely careful and have adequate knowledge of all the forms of hazards. Furthermore, crafting effective and efficient plans and implementation on safety awareness and promoting unconditional use of protective equipment is vital for the safety of miners. However, to underestimate these threats increase the chances of mine work-related accidents and injuries that have the potential to cause disability.

Figure 1.0: Conceptual Frame Work.



Note: adopted by the researcher

2.7 Conclusion

Miners face a plethora of dangers working in the mining sector**.** Occupational injuries are a major contributor to the burden of occupational dangers in the mining sector and workers continue to face a higher risk of fatal injuries. Despite improvements in the working conditions of the mining sectors, fatal injury rates in mining remain more than four times higher the average for all industries. Attempts to improve this situation through legislation have occurred at various times in the history of the mining industry. As a result of these mining hazards, it has led to workers losing body parts, sensory function as well as family members.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter describes the methodology of the study. It covers the profile of the study area, study population, sample size and sampling technique, data collection tool, field data collection, data management and analysis, ethical consideration as well as issues of validity and reliability.

3.1 Research design and approach

A cross-sectional design using quantitative method, was utilized in this study as it suited the study objectives. Cross-sectional surveys are studies designed to determine the frequency (or level) of a particular attribute, such as a specific exposure, disease or any other health-related event, in a defined population at a particular point in time. Therefore, a cross-sectional survey was suitable to investigate workers of Arcelormittal Mining Company's knowledge about the potential hazards in mine work environment.

3.2 Profile of the study area

The study was conducted on Arcelormittal Mining Company, located in Nimba County in Liberia. The County has a total population of 276,863 people Liberia Institute of Statistic and GeoInformation Services (LISGIS, 2008). The extraction of iron ore takes place in mount Tokadeh.

The county has one of the longest mountain ranges in the country with most of it being mined by different mining companies since its discovery. Presently, Arcelormittal is the only mining company that is operating in Mount Tokadeh with more than 2000 workers. The company has constructed a railway that links three major counties in the region namely Nimba, Bong and Grand Bassa to facilitate the transportation of extracted iron ore.

3.3 Study population and inclusion criteria

The study population consists of officials and workers from Arcelormittal mining company in Nimba County, Liberia. The population cut across all status and departments of the physical working group in the company that is from managers to maintenance employees. Respondents' of the study were selected after several visits to their cafeteria and having series of discussions with them. The discussions were meant to gain insights about the nature of the working environment, that is, issues relating to safety and how the authorities of the company responded to safety issues by employees. Inclusion criteria included workers having worked for at least a year in the company and their readiness to participate in the study.

3.4 Sampling technique

A purposive sampling technique was used to select respondents for this study. This sampling technique allowed the researcher to involve respondents who were most useful to the study. This sampling technique is helpful especially in studies where information on safety report is protected by the company, and it is difficult for employees to open up to researchers about safety issues. Under such conditions, it is expedient to select the few who, despite caution, would accept to provide the information being sought. Arcelormittal being one of those companies with similar action (refusal to give out safety report), led to the choice of this procedure of selecting the study respondents. After the purpose of the study was explained to the workers and its benefit to help improve safety in the company, workers voluntarily consented to be selected as respondents of the study.

3.5 Sample size

A total of 202 workers consisting of 7 managers, 20 supervisors, 51 miners and 124 ground workers completed questionnaire. These numbers were chosen to ensure that the sample is representative of the entire workforce. Out of the total respondents of 202, 175 male and 27 female were selected with one female occupying a supervisor position.

3.6 Data collection tools

Arcelormittal mining company runs two working shifts, one during the day and the other at night. The questionnaire were distributed on each of these shifts during break time to enable workers complete them with maximum concentration. For those of the workers that were selected from the night shift, their questionnaires were given to them before the commencement of work. Grey areas raised by workers were duly addressed by the principal researcher and research assistants. Some of the respondents preferred to complete the questionnaire at home and returned them the next day. The data collection took 30 days to complete. The questionnaire used for the study were close questing. Workers' awareness on the dangers of mine work and knowledge of safety measures were measured on a *Likert* scale. Level of awareness of safety rules were measured on a binary scale. A four pointed Likert scale was used in setting up the various category of the scoring. Since the scale had four options, the marking schemes were created ranging from 1-16 and grouped into four different sets. One to four was labeled poor, 5-8 was labeled fair, 9-12 was also labeled good and 13-16 was labeled excellent in the scheme. For every questionnaire of a particular objective whose final score sum up and fit into any of the above scores, were automatically consider as either of the following: excellent, good, fair, or poor. This was done to suit for the number of questionnaire that answered each of the research question. For research questions that had two questionnaires and four options, the scheme were from 1-8. That is 1 and 2 was labeled poor, 3 and 4 fair, 5 and 6 good and 7 and 8 excellent.

3.7 Data analysis

Data was analyzed using *Stata* version 12 to compute means and contracting (stata command) the variables where appropriate. Continuous numeric variables were summarized using means and standard deviation while categorical variables were summarized using frequencies. Awareness on the dangers associated with mining was measured on a *Likert* scale with total frequency counts of 12-16, 8-11, and 5-7 and below 5 constituting excellent, good, fair and poor awareness. Workers knowledge level on safety measures were equally scored on a *Likert* scale with scores of 8 and 7, 6 and 5 and 4 and 3 below 3 constituted excellent, good, fair and poor knowledge. Worker's awareness of safety rules was scored on a binary scale. These value were presented as percentages in the finding of the study considering their total in the various tables. Their totals serve as the basis of the knowledge level on awareness and the adherence of safety rules and prevention the analysis and discussion.

3.8 Ethical considerations

Ethical approval was sought from the Committee on Human Research Publications and Ethics, Kwame Nkrumah University of Science and Technology (KNUST). Respondents signed an informed consent form explaining the purpose of the study and an assurance that they could withdraw from the study at any time if they so wish, before completing the questionnaire.

3.9 Validity and reliability of the study

To ensure validity of the various scales used in the research, a pretest of the questionnaire was done. The pretesting was carried out at the China Union Mining Company that is also located in Bong County. Some questions were reworded based on the responses of pretest respondents. Questions asked in the questionnaire were consistent with research objectives. The main areas covered in the questionnaire included knowledge of workers on safety awareness and prevention, mining hazards as well as frequency of use of protective gear and workers adherence to mine safety rules.

3.10 Conclusion

This chapter discussed the sampling methods and specific workers recruited to provide the information needed in understanding the issues under investigation. Data management and analysis as well as ethical considerations taken to ensure that respondents were not abused and the validity and the reliability are also discussed in the chapter.

CHAPTER FOUR

FINDINGS

4.0 Introduction

This chapter describes the results of the study. The results are summarized in tables, which are complemented by brief write ups that describe the trend in the tables. The chapter covers the demographic data of respondents, workers' knowledge on hazards associated with mine work, workers' knowledge on safety and prevention of injuries that have the potential to cause disability as well as workers' awareness of safety rules.

4.1 Demographic data

From the demographic data, males were in the majority and constituted more than 86% of the respondents. The sample size cut across four categories of workers, with managers constituting 3.43%, supervisors constituting 9.9%, miners constituting 25% and ground workers making up 61.38% of the study respondents. All the workers had formal education, with a little over one-third (37.7%) attaining senior high school education; they were the largest among the respondents, with post graduates being the least (9.14%). Also, all the respondents had some training on work-related safety issues. More than half (53.96%) had both theoretical and piratical training with only a few, constituting 7.43%, having only practical training. The average working experience of respondents was between 2 and 3 years. Table 4.0 presents the demographic characteristics of respondents.

Table 4.0 Percentage of demographic data

Variable	**Percentage**
Age (mean+/-)	34.73 ± 6.84
Gender	
Male	86.63
Female	13.37

Position	
Manager	3.47
Supervisor	3.47
Miner	25.25
Grand worker	61.39
Level of Education	
Primary (elementary)	11.39
Junior high	30.83
High school graduate	37.13
University graduate	10.89
Post graduate	9.41
Training on safety and job practices	
Theory	38.61
Practical	7.43
Both (theory and practical)	53.96
Number of years on job (mean +/-)	2.79 ±1.75

4.2 Worker awareness on dangers associated with working in mine.

As depicted in Table 4.1 below, worker awareness on mining work-related hazards was not very good as the level of awareness of majority of the respondents could be described as either fair or poor. However, miners appeared to have the highest level of awareness among the respondents. Ground workers had the least level of awareness as about two-thirds were ranked either poor (26.61%) or fair (41, 94%)

Table 4.1 Percentage of workers awareness of mining work-related dangers

Ranking	Manager	Supervisor	Miner	Ground worker	total
Excellent	0.00	5.00	5.88	2.42	3.47
Good	42.86	40.00	45.10	25.00	32.18
Fair	57.14	55.00	47.06	41.94	45.05
Poor	0.00	0.00	1.96	26.61	16.83

Worker knowledge on specific elements that can be injurious to their health is presented in Table 4.2 below. Generally, knowledge on this issue was somehow good but the respondents seemed to be more knowledgeable on heat (85.15%), chemicals (63.86%) and fire (90.59%) as specific elements that could be injurious to their health. Managers and supervisor were a bit more knowledgeable than miners and ground workers. For example, all the managers and supervisors had knowledge on heat and fire whereas majority of miners and ground workers were knowledgeable on heat and fire. Also, more than 60% of managers and supervisors had knowledge on loud sound while less than half of miners were knowledgeable on loud sound.

Table 4.2 Percentage of workers knowledge on dangers posed by specific elements

Items	Manager	Supervisor	Miner	Ground worker	Total
	Yes	Yes	Yes	Yes	
Chemical	71.43	80.00	58.82	63.71	63.86
Heat	100.00	100.00	74.50	86.29	85.15
Fire	85.71	100.00	90.19	89.52	90.59
Loud sound	71.43	60.00	45.10	58.87	55.94

Radiation exposure	71.43	75.00	50.98	52.42	54.95

4.3 knowledge of workers on general safety measures

The data showed that less than half of the total respondents had knowledge on general safety measures that would prevent work-related injuries. However, supervisors and ground workers appear to be the most knowledgeable among all the categories of workers. The least knowledgeable among them were managers and miners (see Table 4.3 below).

Table 4.3 Percentage of workers knowledge on safety and preventive measures

Ranking	Manager	Supervisor	Miner	Grand worker	Total
Excellent	0.00	20.00	5.88	6.45	7.43
Good	28.57	45.00	27.45	40.32	37.23
Fair	57.14	35.00	54.90	44.35	46.53

Poor	14.28	0.00	11.76	8.87	8.91

On emergency action, all the managers and supervisors knew of what actions to take during emergency while almost all the other workers knew actions to take during emergencies. Also, all the respondents except ground workers knew of protective measures such as the use of boots and vest. However, just little over two-thirds of the respondents knew of a bump cap as a safety gear; managers were more knowledgeable of this issue than all the other workers. Also, managers were more knowledgeable about the use of ear plug than other workers (see Table 4.4).

Table 4.4 Percentage of worker who have knowledge on protective gear and emergency action

Item	Manager	Supervisor	Miner	Ground worker	Total
	Yes	Yes	Yes	Yes	
Emergency action	100.00	100.00	96.08	98.39	98.02
Safety alarm	71.42	85.00	56.86	72.58	69.80
Glove	100.00	80.00	92.16	87.90	88.61
Boot	100.00	100.00	100.00	98.39	99.01

Vest	100.00	100.00	100.00	98.40	99.01
Bump cap	57.14	35.00	29.41	33.36	33.17
Ear plug	71.42	65.00	43.14	50.00	50.50

4.4 Worker frequency of use of mining protective ware.

The use of protective gear among the respondents was very low as more than half (56%) of the respondents did not use protective gears frequently although their responses indicated that they had high knowledge of the usefulness of protective gears. Miners and ground workers used protective gears more than supervisors and managers probably because of the nature of their work (see Table 4.5)

Table 4.5 Percentage of workers on the frequency of use of protective gear

Ranking	Manager	Supervisor	Miner	Ground worker	Total
High frequency	0.00	15.00	29.41	25.81	24.75
Medium frequency	28.57	10.00	33.33	33.87	31.19
Low frequency	71.43	75.00	37.26	40.32	44.06

4.5 Worker level of awareness on latest safety precaution deployed by the company

Less than 50% of the study respondents had high level of awareness on latest safety precaution measures deployed by the company. Surprisingly, managers seemed to have the least knowledge on this issue and supervisors were most likely to have excellent knowledge. Table 4.6 summarizes worker awareness on the latest safety measures employed by the company.

Table 4.6 Percentage of the workers who were aware of safety precautions deployed by Arcelormittal.

Ranking	Manager	Supervisor	Miner	Ground worker	Total
Excellent	0.00	20.00	17.65	6.45	10.40
Good	28.57	25.00	25.49	25.00	25.25
Fair	57.14	40.00	21.57	41.94	37.13
Poor	14.28	15.00	35.29	26.61	27.23

4.6 Measures employed by Arcelormittal Mining Company to improve safety on the mine.

Majority of the respondents said they had adopted safety measures available at the company (see Table 4.7) For example, more than 90% of the respondents said they adopted pre-training before work, (96.04%), undertook daily safety training.

Table 4.7 Percentage of workers who frequently utilize standard safety measures in place (once a month)

Measure	Manager Yes	Supervisor Yes	Miner Yes	Ground worker Yes	Total
Orientation training	100.00	100.00	96.08	98.39	98.02

Safety guide booklet	57.14	80.00	27.45	59.68	53.47
Safety training before work	28.57	100.00	98.04	98.39	96.04

4.7 Conclusion

The foregoing chapter discussed the findings of the study. It described the demography information of the study respondents, worker awareness of hazards in the mine, worker knowledge on safety and preventive measure, prevention of work related practices that may cause disability, as well as workers awareness on safety gear and emergency action. It also described how frequently protective gears that were used, workers awareness on safety measures alongside workers adaptation to safety measure deployed by Arcelormittal. The next chapter will discuss these findings and their implications.

CHAPTER FIVE

DISCUSSION

5.0 Introduction

This chapter presents discussions of the findings including the implications of the results. It is preceded by a recap of key findings followed by the demographic profile of respondents, workers' awareness on dangers associated with working in the mine, knowledge of workers on safety and preventive measures.

5.1 Key findings

A mean age of 34.73 years, suggests the company has a mainly youthful workforce. The vast majority of workers were ground workers with miners constituting a fourth of all workers. Majority of workers had fair knowledge of the inherent dangers associated with mining. The vast majority of respondents were privy to the obvious dangers posed by specific elements within the mine. Supervisors and ground workers tended to be more knowledgeable on specific safety and preventive measures compared to miners. Almost all respondents were privy to general emergency actions, while most workers were knowledgeable on the various protective gear, a sizable number had little knowledge of the bump cap. Miners tended to have the highest frequency of usage of protective gear compared to all other workers. Miners generally had lesser knowledge of the latest safety precautions deployed by management compared to supervisors and managers. Orientation training upon job reassignment was the most utilized standard safety measure by workers.

5.2 Demographic profile of respondents

As the findings indicated, majority of the respondents were young. A possible reason for the youthful age of respondents could be that majority of the respondents were ground workers (86.64%). These jobs are physically demanding and require greater endurance on the side of workers, thus making the youth most suited for the job as affirmed by Pransky et al. (2005). These jobs are also potentially risky and demand that workers should be knowledgeable on safety measures to prevent accidents. The youthful workforce of the company has some advantages for the company in terms of workplace safety. A youthful workforce would likely reduce accidents due to their quick reflexes that is reiterated by Ilmarinen, (2001). They can also be easily introduced to and adopt new technologies and safety measures that have the potential of reducing accidents. Furthermore, young people can easily be retrained or shifted to another department of the production line after injury. However, accidents can only be reduced if they are they have adequate knowledge of safety measures and if they adhere to these. Also, injuries sustained by a youthful workforce are likely to have more debilitating or negative effects on the productivity of the individual as well as the company if such injuries are not properly handled.

5.3 Workers' awareness and knowledge of dangers associated with working in the mine

With a mean work experience of 2.79 years, it is expected that respondents would be familiar with the basic safety rules because they had enough working experience to learn on the job. In addition, there is a possibility that they might have experienced accidents within the period and should have gained valuable experiences from such events. For example, workers with personal experiences with accidents and safety within the mine tend to act to forestall any recurrence as it was also reiterated by International labor organization (2016).

However, the findings indicated many of respondents lack awareness of dangers associated with mining and this could have grave consequences for the workforce and the company at large. Of greater concern is the fact that less than half of managers had good or excellent knowledge on the dangers associated with mining. Managers have oversight responsibility for supervisors and miners as well. Their lack of thorough awareness on persistent dangers associated with mining implies they are not likely to act to forestall any accidents associated with those dangers. Moreover, they are likely not to appreciate these dangers when reported by supervisors, delaying action on them. On the flip side the more than half of miners who had good or excellent awareness of the dangers are likely to act to prevent accidents associated with these dangers.

It is interesting to note that despite majority of managers not being aware of the inherent dangers associated with mining, they had considerable knowledge on the dangers posed by specific elements within the mine. These specific elements include heat, fire and loud sound. A possible reason for this occurrence could be the visible nature of the specific elements compared to the more imperceptible dangers such as landslides. Generally, supervisors proved to be more knowledgeable compared to managers and miners on the dangers posed by specific elements within the mines. The fact that supervisors are in constant touch with miners and largely operate from there could be responsible for this difference in knowledge compared to managers. Prior experience with mine work could account for the difference between the better knowledge of supervisors compared to miners. However it is possible miners will not suffer a higher rate of accident due to their lesser knowledge on specific elements as they often operate under the tutelage of mangers.

The general lack of awareness on dangers associated with mining, which is similar to the findings of Bahn, (2013) could be attributed to workers low educational attainment, which may have made it impossible for them to follow safety instructions within the mine, especially instructions in written format. As espoused by Stanley and Manthorpe, (2004) being able to read safety instructions is important in avoiding potential injury and accidents, and so, if workers are unable to read instructions, frequency of accidents is likely to rise. Another possible cause of lack of awareness is inadequate practical and theoretical training on safety issues. Exposure to both practical and theoretical training would likely increase their level of knowledge and awareness to avoid accidents and injuries. They are also likely to seek further clarifications in case there is a gap between theoretical and practical training, further increasing their level of awareness and thus reducing their chances of accidents or injuries. Moreover, with practical and theoretical training, workers are likely to employ all safety measures available to avert any potential danger. They are likely to utilize all available protective gears including clothing, boots and helmets. They are also likely to report on any compromises in terms of safety within and around the mines.

The lack of knowledge on safety measures would possibly expose workers to injuries that will lead to long term disabilities as reaffirmed by Golovina et al., (2015). Supervisors being more knowledgeable on specific safety measures compared to managers could be due to their hands on experiences within the mines. On the other hand miners having less knowledge on specific safety measures could be attributed to their lesser level of work experience within the mines as supervisors are often the most experienced miners. A miner being more knowledgeable on safety measures compared to ground workers is generally asserts the difference in their knowledge is due to the fact that miners are exposed to far more dangers as compared to ground workers reaffirmed by Biswak (2001). Generally, workers who are not privy to safety rules and its implication on their health are likely to adopt a laid back attitude towards those rules which was also indicated by Weichbrodt, (2015). Also, workers who adhere to all safety rules and yet suffer accidents and injuries from accidents that they had little control over, such as landslides may lose faith in the entire safety system. Such individuals may ignore personal safety precautions such as protective boots and bump caps, knowing very well that they had very little control of previous accidents as espoused by Weichbrodt, (2015).

5.4 Knowledge of workers on emergency actions, protective gear and frequency of usage of protective gear

The fact that supervisors and managers were more knowledgeable on emergency action compared to miners can be due to a lack of practical training or enforcement of emergency procedures for miners. Supervisors, by virtue of their higher rank compared to miners are likely to make input into which emergency equipment or actions are installed by management. They are equally responsible for ensuring miners are privy to the most basic of emergency actions as well as their enforcement. Thus miners and ground workers are likely the last in the chain of command to be on the known in terms of emergency procedures. They are therefore absolutely dependent on the training given to them. This training is further boosted by the strict enforcement of emergency procedures.

The laxity in enforcing emergency actions is equally reflected in the fact that over a third of miners admitted to low frequency usage of protective gear. Protective gears are the first line of defense against unforeseen accidents. Not being in protective gear on a regular basis implies miners are likely to suffer avoidable accidents or sustain severer injuries that could lead to disablement. It is interesting to note that supervisors actually admitted to a lower frequency of usage of protective gear compared to miners. A possible reason for this could be the fact that supervisors do limited manual work within the mines and thus view themselves as not being in immediate danger in terms of mine accidents. However, this thinking is erroneous as it asserts the most severe mine accidents are spontaneous and could subject workers without protective gear to severer injuries as it is reiterated by the United State Department of Labor, (2007).

5.5 Awareness of workers of latest safety precautions deployed by company and utilization of standard safety measures

In most mining firms extra-ordinary safety measures are introduced if accidents or injuries occurred frequently as reaffirmed by United States Department of Labor, (2007) and McLaughlin, (2006). Arcellomital Mining Company adopted the latest precautionary measures in the wake of a tragic accident that occurred in the mine in 2011. Although respondents had some knowledge on the extra-ordinary precautions that were implemented after the last accidents, they were not certain about what they were designed to achieve. The lack of knowledge of what the precautions were about would likely make the enforcement of the new measures difficult due to the ambiguity of their intended purposes among the workers. However, supervisors tended to be more knowledgeable on these extra-ordinary measures compared to miners. Thus with more communication and hands on approach from supervisors, miners' knowledge of these installed measures will likely improve.

The less than a third of miners who frequently use the safety guide booklet stand a lesser risk of being involved in accidents within the mines as almost all new dangers and demarcations are covered in the booklet. A possible reason for this could be the lower literacy rates of miners as they are likely to prefer hands on training methods compared to the updates of safety within the booklets. As it is reaffirmed by Poplin et.al (2007), almost all respondents partaking in orientation training and safety training before work is an indication that they are likely to be better adapted to their work and subsequently avoid serious injuries that may lead to long term disabilities.

5.6 Limitation of the study

The attainment and selection of the study respondents for the required information was difficult because workers believed that it was consuming their working time. One major issue was the company refusal to provide their safety report from 2014 and 2015. Additionally, transportation, convincing the worker to provide the necessary information was pressing. Because of these conditions, researcher can delve into further investigations to reduce the odd of the basis limitation in this research.

5.7 Conclusion

Workers' knowledge and awareness on the prevention of accidents and injuries depend on the dissemination of safety information and the frequent use of protective equipment. Thus providing safety awareness and providing numerous trainings will go a long way in avoiding long term injuries related to mining.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION OF THE STUDY

6.0 Introduction

This chapter deals with the conclusion and recommendations of the study.

6.1 Conclusions

This study acknowledged the knowledge and awareness of workers of Arcelormittal mining company in Liberian about mine hazards that are potentials cause of accidents and injuries that lead to disability. Accidents and injuries have become inevitable in our society. This is largely because of the world's advancement in technology, and mining, being one major sector that hugely depends on technological equipment. Mining has thus been a hazardous profession that is of concern to the whole world, but it has not been easy eliminate the dangers associated with mining for several reasons. . The profit motive of employers at the expense of the lives of their employees is one of the major factors. Another major factor is lack of training on the part of employees to increase their knowledge on the dangers associated with mining to minimize the occurrence of accidents and injuries.

The findings of the study showed that majority of the employees are junior high leavers and had little access to both practical and theoretical training thus limiting their ability to access information on the dangers associated with mining. The finding also highlighted workers awareness of hazards and safety measures. The findings indicated that knowledge of workers on general safety issues at workplace was not all that good. This is implies that a lot education must be undertaken to enable workers of the company to acquire more knowledge on safety issues. More so, employer should ensure that all workers adhered to the company’s general safety rules and procedure in order to eradicate irreversible harm.

6.2 Recommendation

As good health is vital to all in respective of where or what occupation one finds oneself, prioritizing positive work practice behavior should be the goal of all entities. Though Mining hazards still serve as a major concern of the working society, policy makers, and other stakeholders should ensure that:

- quarterly publication of safety and health report of all mining institutions, which will assist safety practitioner, stake holders and other policy makers to design strategies’ for the mitigation of the reoccurrence of those hazardous conditions found in mine.
- Additionally, Arcelormittal Mining Company should institute a taskforce of health and safety practitioners who will monitor workers adherence to safety measures to ensure that accidents are minimized.

- The team should also ensure that both government and company health and safety policy be synchronized into standardize work safety practices, which will also serve as a requirement for their job description.

Straight and Effective adherence to these measures and their implementation will enhance in minimizing accidents and injuries that are potential to lead to disability among workers in mines and other industries**.**

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APPENDIX

Appendix A: Questionnaire

Dear sir/madam,

My name is Alexander Mingei Nakamu Jr. A student at the Kwame Nkrumah University of Science and Technology (KNUST) reading public health in disability rehabilitation and development studies. I am conducting studies on mining hazards causes and effects that lead to disability. I kindly ask for your assistance in answering my questionnaires.

Direction: please tick yes/no if the statement is true/false and circle the letter that best answer the statement.

1. Name of county_________________________
2. Name of the company you work with; Arcelormittal___.
3. Sex of the participant; male___/ female____
4. Job description of the employee, manager__ supervisor___ miner___ machine operator ____others____
5. How long have you work for this company? _____
6. What is your level of education elementary___ junior high ___ high school graduate___ undergraduate degree___ graduate and above ___?
7. What is the specific job you do at this company ______________________?
8. Have you had any form of training before starting the job? Yes___/ no ___
9. What kind of training? Practical__/ theory__ both____
10. Do you agree exposure to dust can cause respiratory disease?

A. Strongly agree,

B. Agree c.

C. Disagree

D. strongly disagree.

11. Do you agree that chemical leakage can cause you physical injuries?

A. Strongly agree

B. Agree

C. Disagree

D. strongly disagree

12. Do you agree that exposed electric wire in the mine could cause you electrocution?

A. Strongly agree

B. Agree

C. Disagree

D. Strongly disagree

13. Do you know that there is a higher risk of landslide in a mine?

A. strongly agree

B. Agree

C. Disagree

D. strongly disagree?

14. Are you convinced that wearing safety materials could help prevent you from injuries?

A. Strongly agree

B. agree

C. disagree
D. strongly disagree.

15. Do you believed that, straightly adhering to safety policies could reduce your chances of been injured?

A. strongly agree

B. agree

C. disagree

D. strongly disagree

15. Are you convinced that if miner mined using shaft slope mining other than drift mining could prevent land sliding? A. Agree

B. Strongly agree

C. Disagree

D. strongly disagree

16. Are you aware of the most basic safety rule?

A. Conscious B. Very conscious

C. Not conscious.

17. How often are you likely to wear your protective gears?

A. All the time

B. Sometime

C. Not often

D. Not at all

18. Are you aware of emergency actions before and after work? Yes_____ No_____

19. Are you aware of any safety/emergency alarm at your workplace? Yes__/No__

20. Were you informed about what to do when the alarm rings? Yes__/No__

21. Were you given escape route in case there is danger at you work station? Yes__/No__

No:	Items	Yes	No
A	Were you given safety materials? If yes please take the items issues		
B	Glove		
C	Boot (steel toes)		
D	High visibility vest		
E	Safety goggle		
F	Bump cap		
G	Helmet		

H	Ear plug		

23	Are you aware that working in the mine could cause you the following	Yes	No
F	fire		
G	Radiation exposure		
H	Exposure to hazardous chemical splashes		
I	Heat		
J	Loud sound		

APPENDIX B: Managers/supervisors questionnaires

My name is Alexander Mingei Nakamu Jr. a student at the Kwame Nkrumah University of Science and Technology (KNUST) reading public health in Disability Rehabilitation and Development Studies. I am conducting studies on mining injuries causes and effects that lead to disability. I kindly ask for your assistance in answering my questionnaires

Direction: Please tick **YES** if the statement is true and tick **NO** if the statement is false

1 Do you recruit your employees by application? Yes-___/No___

2. Do they apply using letter? Yes___/No___
3. Do you have any employee that were recommended without letter? Yes___/No___
4. Do you train them before commencing work? Yes__/No__
5. Do you acquaint your employees on these things in the table below before they start working for the company?

	Items	Yes	No
	Meaning of safety		
	Alert sign		
	Warning sign		
	Risk associated with their work		
	Accident		
	Injury		
	Accident that are common while they are working		
	Accident that lead to injury		
	Injuries the lead to impairment		
	Impairment that lead to disability		

6. Are they informed about what to do when alerted? Yes__/No__

7. Do you provide direction for escape in case of danger at the job site? Yes__/No__

8. Do you provide standard safety protection suit for your employees? Yes__/No__

9. If any of your workers are involved in accident, do you immediately give them medical care?

Yes__/No__

10. Do you carry out inspection to ensure safety rules are observed at the work site? Yes__/No__

11. Do you provide first aid box at every work station? Yes__/No__

9. Have you had any form of training before starting the job? Yes___/ No ___
10. What kind of training? Practical__/ theory__ Both____
11. Do you train employees based on the job they were hired for? Yes___/ NO__
12. What is the length of the training? _____
13. Have you ever received any accident case from the job site while working? Yes___ No__
14. Do you keep track on the number of time your employee experience accident? _______
15. Have you been injured before? Yes____/ No___
16. Do you know which part of the body most of your employees get injured? Head___, Hand___ foot___ body___
17. Do you take your employee to hospital immediately after accident? Yes___? No___
18. How do you ensure treatment of your for employees done? Minor___ Major___ full recovery___
19. Do you give time out to employees because of your injury? Yes__/No___
20. Do your employee receive salary while recovering from injury? Yes__ No__
21. Do you provide information on safety to them? Yes__/No__
22. Do you provide safety awareness on a daily basis before beginning work? Yes_____ No_____
23. Do you conduct any awareness/training on safety at your workplace? Yes__/No__
24. Do you issue safety materials before starting work in this company? Yes__/No__
25. Do provide information on any safety/emergency alarm at you workplace? Yes__/No__
26. Do you inform them about what to do when the alarm rings? Yes__/No__
27. Do you specified escape route in case there is danger at work station? Yes__/No__
28. Do you allow them to carry safety manual along while at their work station? Yes__/No__
29. Do you reduces work responsibilities for them as a result of injury sustained at work? Yes__/ No__

30. How do you feel being restricted as the result of the injury you have acquired? Good__ Bad__ normal__

31. Where you educated on the level of exposure to sound and radiation? Yes___/ No___

32. Do you know of anybody who wasinjured and didn't return to work because of their injury? Yes__/No__

33. Do you have any information on the person's status in terms of benefits? Yes__/No__

34. Do you have any policy in place on safety? Yes___/ No___

35. Do you stress the dangers associated with employee not adhering to the usage of the listed items in the table? Tick under yes if the statement/item is true and No if it is not false.

No:	**Items**	**Yes**	**No**
A	Do you give safety materials? If yes please take the items issued		
B	Glove		
C	Boot (steel Toes)		
D	High Visibility Vest		
E	Safety Goggle		
F	Bump Cap		
G	Helmet		
H	Ear plug		

35	Are you aware that working in the mine could cause your employee the following if they are fully educated on safety and dangers?	Yes	No
A	Loss of eye sight		
B	Loss of hearing		
C	Loss of limb(s)		
D	Early retirement		
E	Skin irritation		
	Are you aware that the following could harm you?		
F	Burn		
G	Radiation Exposure		
H	Exposure to hazardous chemical splashes		
I	Heat		
	Loud sound beyond normal decibels level		

36	Are you aware that losing any of your body parts or function can lead to the following		

A	Employment restriction		
B	Social Participation		
C	Right abuse		
D	Financial difficulties		
F	Functional restriction		

37. Do you have a record of those that got injured on the job? Yes_______ No____

38. What is the estimated number of those that got injured from 2014 - 2015? ________
39. Number of males injured_________, No females injured_________

40. How many employees died due to injury? _____________

41. Number of males that died ______________ Number of females that died_________ Please attend to the following questionnaire by circling the letters that best answered the question.

42. Do you agree exposure to dust can cause respiratory disease?

B. Strongly agree,

B. Agree c.

C. Disagree

D. strongly disagree.

43. Do you agree that chemical leakage can cause you physical injuries?

A. Strongly agree

B. Agree

C. Disagree

D. strongly disagree

44. Do you agree that exposed electric wire in the mine could cause you electrocution?

A. Strongly agree

B. Agree

C. Disagree

D. Strongly disagree

45. Do you know that there is a higher risk of landslide in a mine?

A. strongly agree

B. Agree

C. Disagree
D. strongly disagree?

46. Are you convinced that wearing safety materials could help prevent you from injuries?

A. Strongly agree

B. agree

C. disagree

D. strongly disagree.

47. Do you believed that, straightly adhering to safety policies could reduce your chances of been injured?

A. strongly agree

B. agree

C. disagree

D. strongly disagree

48. Are you convinced that if miner mined using shaft slope mining other than drift mining could prevent land sliding? A. Agree

B. Strongly agree

C. Disagree

D. strongly disagree

49. Are you aware of the most basic safety rule?

A. Conscious B. Very conscious

C. Not conscious.

50. How often are you likely to wear your protective gears?
A. All the time

B. Sometime

C. Not often

D. Not at all **APPENDIX C: Consent Form for Mangers and supervisor Respondents Information Leaflet and Consent Form for Mangers and supervisor**

This leaflet was be given to all prospective respondents to enable them to know enough about the research before deciding whether or not to participate

Title of Research: Knowledge of mine workers on mine related hazards and prevention: a case study of mine workers at Arcelormittal mining company in Yekapa Nimba county Liberia.

Name(s) and affiliation(s) of researcher(s): This study is being conducted by Alexander Mingei Nakamu Jr., a Second year Master of Science student, in Disability, Rehabilitation and Development Studies offered at Department of Community Health, Kwame Nkrumah University of Science and Technology (KNUST), Kumasi.

Background: Knowledge of workers on work-related injuries is crucial because such injuries have the potential to cause disability. Knowledge on the risk factors is crucial in preventing long term disablement that has the tendency to disrupt workers' quality of life and boost the productivity of mining companies.

Objective: To ascertain the level of knowledge of workers of Arcelormittal Mining Company on work related hazards that have the potential to cause disability.

Methods: A purposive sampling technique was use to selected a total of 202 workers, consisting of 7 managers, 20 supervisors, 51 miners and 124 ground workers for the study. These respondents were chosen to ensure that the sample is representative of the entire workforce. A questionnaire with close-ended items will be used to collect information from the respondents.

Risk(s): The risk of this questionnaire is that it will take much of the respondents' time due to the tendency on the part of the respondents to sound emotional at some point during the interview.

Advantage(s): The study questionnaire will enable the respondents to share their knowledge and experiences on mining hazards and it negative impacts on workers. It will provide a medium of communication between the workers and the researcher on other general information about safety and prevention of accidents and injuries in mine.

Confidentiality: The respondent is guaranteed full confidentiality and full anonymity. Nothing in this questionnaire will be revealed to other respondents or community dwellors.

Voluntarism: Respondents to the study is completely voluntary.

Withdrawal from the research: Withdrawal from the research can be done at any time.

Consequence of Withdrawal: There will be no consequence, loss of benefit or care to you if you choose to withdraw from the study. Please note however, that some of the information may be modified or used in analysis, reports and publications. These cannot be removed anymore. We do promise to comply with your wishes as much as practicable.

Costs/Compensation: There is no compensation for participating.

Contacts: Alexander Mingei Nakamu Jr.

Tel: +233554486018/+2335787318034 (Ghana) and +231886441814/+231776813196 (Lliberia)

Further, if you have any concern about the conduct of this study, your welfare or your rights as a research respondent, you may contact:

The Chairman Committee on Human Research and Publication Ethics Kumasi Tel: 22301-4 ext 1098 or 020 5453785

CONSENT FORM

Statement of person obtaining informed consent:

I have fully explained this research to ___________________________________ and have given sufficient information, including that about risks and benefits, to enable the prospective respondent make an informed decision to or not to participate.

DATE: _____________________ NAME: _________________________________

Statement of person giving consent

I have read the information on this study/research or have had it translated into a language I understand. I have also talked it over with the distributor of the questionnaire to my satisfaction.

I understand that my respondent is voluntary (not compulsory).

I know enough about the objective, methods, risks and benefits of the research study to decide that I want to take part in it.

I understand that I may freely stop being part of this study at any time without having to explain myself.

I have received a copy of this information leaflet and consent form to keep for myself.

Name____

Date: ____________ Signature: ________________________

APPENDIX D: Consent Form for miner and ground worker

Respondents Information Leaflet and Consent Form for miner and ground worker

<u>This leaflet was be given to all prospective respondents to enable them to know enough about the research before deciding whether or not to participate</u>

Title of Research: Knowledge of mine workers on mine related hazards and prevention: a case study of mine workers at Arcelormittal mining company in Yekapa Nimba county Liberia.

Name(s) and affiliation(s) of researcher(s): This study is being conducted by Alexander Mingei Nakamu Jr., a Second year Master of Science student, in Disability, Rehabilitation and Development Studies offered at Department of Community Health, Kwame Nkrumah University of Science and Technology (KNUST), Kumasi.

Background: Knowledge of workers on work-related injuries is crucial because such injuries have the potential to cause disability. Knowledge on the risk factors is crucial in preventing long term disablement that has the tendency to disrupt workers' quality of life and boost the productivity of mining companies.

Objective: To ascertain the level of knowledge of workers of Arcelormittal Mining Company on work related hazards that have the potential to cause disability.

Methods: A purposive sampling technique was use to selected a total of 202 workers, consisting of 7 managers, 20 supervisors, 51 miners and 124 ground workers for the study. These respondents were chosen to ensure that the sample is representative of the entire workforce. A questionnaire with close-ended items will be used to collect information from the respondents.

Risk(s): The risk of this questionnaire is that it will take much of the respondents' time due to the tendency on the part of the respondents to sound emotional at some point during the interview.

Advantage(s): The study questionnaire will enable the respondents to share their knowledge and experiences on mining hazards and it negative impacts on workers. It will provide a medium of communication between the workers and the researcher on other general information about safety and prevention of accidents and injuries in mine.

Confidentiality: The respondent is guaranteed full confidentiality and full anonymity. Nothing in this questionnaire will be revealed to other respondents or community dwellors.

Voluntarism: Respondents to the study is completely voluntary.

Withdrawal from the research: Withdrawal from the research can be done at any time.

Consequence of Withdrawal: There will be no consequence, loss of benefit or care to you if you choose to withdraw from the study. Please note however, that some of the information may be modified or used in analysis, reports and publications. These cannot be removed anymore. We do promise to comply with your wishes as much as practicable.

Costs/Compensation: There is no compensation for participating.

Contacts: Alexander Mingei Nakamu Jr.
Tel: +233554486018/+2335787318034 (Ghana) and +231886441814/+231776813196 (Lliberia)

Further, if you have any concern about the conduct of this study, your welfare or your rights as a research respondent, you may contact:

The Chairman Committee on Human Research and Publication Ethics Kumasi Tel: 22301-4 ext 1098 or 020 5453785

CONSENT FORM

Statement of person obtaining informed consent:

I have fully explained this research to ___________________________________ and have given sufficient information, including that about risks and benefits, to enable the prospective respondent make an informed decision to or not to participate.

DATE: _____________________ NAME: _________________________________

Statement of person giving consent

I have read the information on this study/research or have had it translated into a language I understand. I have also talked it over with the distributor of the questionnaire to my satisfaction.

I understand that my respondent is voluntary (not compulsory).

I know enough about the objective, methods, risks and benefits of the research study to decide that I want to take part in it.

I understand that I may freely stop being part of this study at any time without having to explain myself.

I have received a copy of this information leaflet and consent form to keep for myself.

Name____

DATE: ____________ SIGNATURE/THUMB PRINT: ________________________