

**UNIVERSITY
OF
LUSAKA**

SCHOOL OF MEDICINE AND HEALTH SCIENCES

**AN INVESTIGATION INTO FACTORS CONTRIBUTING TO NOISE INDUCED
HEARING LOSS AMONG MINERS AT CHIBULUMA MINE PLC IN KALULUSHI
DISTRICT, COPPERBELT PROVINCE.**

BY

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**A research dissertation submitted to the University of Lusaka in partial fulfilment of the
requirements of a degree in Bachelor of Science in Public Health**

DISSERTATION DECLARATION AND CLEARANCE

I, Ackride Mulenga certify that this dissertation is my original work, this work has been produced been produced under the guidance of my university appointed supervisor. I further declare that it is in compliance with the requirements for the award of Bachelor of Science in Public Health degree as set by the University of Lusaka. I also attest to the fact that neither a part nor a whole of it has been subject to any submission to any other academic institution for the award of any programme. All cited references have been acknowledged.


Signature

Date :7th June 2023

Supervisor: TRESFORD SIKAZWE (MR)

I, Tresford Sikazwe, having guided, read this dissertation and approved it for submission, confirm that I am satisfied that this is the original work of the student under whose name it is presented. I further attest that the work has been completed satisfactorily and is ready for presentation to the examiners.


Signature

Date: 31st May, 2023

DEDICATION

I want to dedicate this work to my loving wife, Patricia Mulenga Kalwisha, who has always been there for me and made sure I did everything I could to finish what I started. and to my little children, who have been impacted in every way by this journey.

The study is also a dedication to all employees who were diagnosed with noise induced hearing loss and those who are continuously being exposed to excessive noise in their working environment at the Chibuluma mine Plc.

Many thanks. God bless you all.

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LIST OF ABBREVIATIONS AND ACRONYMS

dB Decibels (international standard unit for noise level) this is normally measured using a Sound level meter.

EMA Environmental Management Act

ZEMA Zambia Environmental management agency.

SI Statutory Instrument

TWA Time weighted average

ACGIH American Conference of Governmental Industrial Hygienists

NIOSH National Institute of Occupational Safety & Health (USA)

OSHA Occupational Health & Safety Administration (USA)

OEL Occupational Exposure Limit

LAeq, A-weighted equivalent-continuous sound level, also called average sound level, with 3-dB exchange rate, normalized to 8 hours.

ABSTRACT

Background: Noise induced hearing loss has been reported amongst the three top occupational health diseases within the mines in Zambia. One's occupation is wide spread risk factor, the strong evidence linking it to a significant health outcome loss. In Zambia any employee diagnosed with Noise induced Hearing Loss restricted to low noise level working areas and or is medically discharged from the Mining Sector if an alternative place of work cannot be found.

It is therefore imperative that the factors responsible for Noise Induced hearing Loss are identified and make recommendations to reduce the impacts.

Study Method: A qualitative, phenomenological, exploratory, descriptive and contextual design was applied in order to explore and describe the factors that contribute to noise induced hearing loss. A purposive and convenience sampling was used to select the participants in this study. Therefore, interviews, observation, documentation and virtual materials were used to collect data. Probing questions were asked to follow up, seek clarity and obtain more information through an interview guide. All the interviews were captured on a voice recorder and field notes were taken on observable behaviors.

Results: The following themes emerged: experiences and challenges faced by employees in the work environment, noise hazards and health employees, hearing protective device factors and management and leadership factors. The study reviewed that employees were faced with different challenges in their work environment. The challenges included the nonexistence of noise hazards, implementation of screening tests and maintenance and repair of faulty equipment. Such challenges were perceived to be some of the contributing factors NIHL at Chibuluma Mine Plc.

Conclusion: The results of this study indicated that induced hearing loss was caused by a combination various contributing factor. Failure to apply the guidelines, policies and procedure from the department of mines resulted in employees developing noise induced hearing loss. The employees also reported that the employer takes time to repair broken protective hearing devices

CHAPTER ONE: INTRODUCTION

1.1 Background to the study

Chibuluma Mine Plc which is the context of this study is located in Copperbelt province about 12 km from Kalulushi Central Business Corridors. Chibuluma Mine is associated with excessive occupational noise exposure, resulting from the utilization of heavy mobile equipment use, this equipment is used for primary and secondary drilling and blasting and delivery of the Ore until the final product of the concentrate is achieved. The use of heavy mobile equipment can cause detrimental health effects, one being occupational noise induced hearing loss (Schust 2004). The department of mineral resources identified noise induced hearing loss as a significant risk that needs to be controlled in a sustainable process. Further, the Mine under study in Copperbelt Province employs approximately 980 people who are responsible for the safe production of Sulphide Ore. Chibuluma mine Plc runs 24 hours a day, 365 days a year. The organization under study is not the only mining house in Copperbelt Province, therefore over exposure to occupational noise could be an industry wide problem within Copperbelt Province.

According to Belojevic, (2007), auditory effects or any other effects may develop to any person at any frequency level depending on the individual exposure to noise situation. Noise exposure is a wide spread problem in mining due to the use of heavy equipment, drilling, rock breaking, transferring, sorting and milling of rocks as well as confined working environments (Van dyk and Banyini, 2011). Excessive noise exposure in the work place can limit a workers ability to communicate and hear signals, which can impact on their safety and productivity (Edwards and Kritzinger, 2012). Long term noise increases the risk of hearing loss, with implications for workers health, employment prospects and overall quality of life (Edwards et al, 2011). The damage that result from excessive noise manifest as Noise Induced Hearing Loss (NIHL).

Auditory effects or any other health effects may develop to any person at any frequency level depending upon the individual exposure to noise situation. Low-frequency noise (Schust 2004), up to 100 Hz may cause non-aural physiological and psychological effects below the individual hearing threshold (Leventhal et al., 2003) also emphasized that 10-200 Hz frequency noise is an environmental noise sensitive to people in their homes and offices. This is the group which generates many complaints and is generally seen to the people of middle age. It may also occur to

the subjects working in the industry but generally found at levels well above threshold. Similarly, low-frequency noise (Nakashima et al., 2007) produced by the armored vehicle also causes negative effects on reaction time to the normal hearing subjects.

Further Pal et al.(2000) have investigated that dozer, dumper, screen plant and pit exhaust fan generate noise in the alarming frequency range of 250-500 Hz. Similarly, haulage machine generates noise at dominating frequency of 1.6 kHz. When spectral noise level of 50 dB SPL is applied at the mid frequencies, viz., 1 and 3 kHz to the exposed subjects, auditory sensitivity loss increases with the decrease of loss of frequency selectivity linearly Pal et al., 2000; Mahmood *et al.*, 2004 studied that there is an increase in systolic and diastolic blood pressure to the young adults exposed to the noise level of 90 dBA at 4 kHz. Subjects working in a Hydroelectric Power Plant generally exposed to the noise levels in the range of 95-110 dBA at 2-8 kHz and hearing loss occurs within the first 10 years of exposure to noise and a dip found at 4 kHz (Celik et al., 1998). The subjects exposed to the high level of noise produced by aircraft and heavy machinery exhibited notch at 6 kHz (McBride et al., 2001). Similarly, road traffic noise contributes high-frequency noise level of 70 dBA which causes listening interference equivalent to 3 dB (Satish et al., 2008).

1.2 STATEMENT OF THE PROBLEM

Dangerous noise level exposures might be more widespread in mining than in any other major industrial sector due to a large number of persons employed by the mining sector and as a consequence, a large number of employees might be affected. Chibuluma Mine Plc has a total workforce of 980 which is a breakdown of males 600 and females 380.

Presently, according to Chibuluma Mine Plc strategic plan (2019-2023) all the aforementioned employees are exposed to noise on a daily basis. About 400 employees on a daily basis are exposed to induced noise hearing loss. Annually 12 or more employees are diagnosed with induced noise hearing loss and because of the nature of the environment and the Occupational Health and Safety Act of 2010 of Zambia, the employees diagnosed with hearing loss are discharged from employment or redirected to a less noise environment as well as the provisions in the Environmental Management Act which demands for the regulation of noise in industries

In addition, the Mine sends employees annually for hearing test, gives them hearing plugs and some noise signage are placed but not adequate. In trying to counteract induced noise hearing loss Chibuluma Mine Plc has come up with a medical program where each employee attends annual medical examinations. Conditions of interest in the medical exam include lung function test (chest x-ray) hearing test (audiometry tests) and eye tests. The Mine operates a number of heavy equipment and machinery which generates a lot of noise and hence most employees are exposed to noise causing a number of them to be at risk of suffering noise induced hearing loss. Chibuluma mine Plc runs 24 hours a day, 365 days a year. Chibuluma Mine Plc has not yet developed a hearing conservation program, that is inclusion of noise induced hearing loss in the induction of employees, so that they are aware of the effects of noise. The mine does not have adequate signage placed in strategic area where much noise is emanating from and does not offer double plug hearing, there is no limited time of exposure of noise to employees. The mine does not rotate department so that one employee is not placed in the same environment for a long time and provision of silencers to noise equipment such as underground fans is also a challenge which need to be dealt with by the organization. The organization under study is not the only mining house in Copperbelt province, therefore over exposure to occupational noise could be an industry wide problem within copperbelt province. Limited studies conducted on Chibuluma mine exposure data exist in Zambia, hence the need for this study to investigate the factors contributing to NIHL at Chibuluma mine Plc.

1.3 JUSTIFICATION OF THE STUDY

The existing body of knowledge on NIHL is extensive. However, the preceding discussion evokes the question: what are the factors contributing to NIHL? The rationale for this study is that occupational Health and safety Services at Chibuluma Mine PLC does not conduct audiological examinations and there is need to have detailed information about NIHL in the mining industry (and therefore the answer to the above question) for the purpose of attaining best clinical practice with this population, for example awareness of expected hearing loss. Hearing conservation program need to be introduced and regularly reviewed, therefore the mines needs audiological information that will help to make decisions concerning its hearing conservation programs, for example the information that needs to be conveyed to miners about the dangers to their hearing.

1.4 Study objectives

1.4.1 Aim of the study

The study aims at investigating factors contributing to Noise Induced Hearing Loss among miners at Chibuluma Mine PLC

1.5.2 Specific objectives

- (i) To explore factors contributing to NIHL among miners at Chibuluma Mine Plc.
- (ii) To determine the number of miners that have developed NIHL at Chibuluma Mine Plc.
- (iii) To examine the hearing protection programs and policies that have been developed by management to protect miners from developing NIHL
- (iv) To assess the extent to which mine workers are adhering to hearing protection policies and regulations put in place by management

1.5.3 RESEARCH QUESTIONS

- i) What factors contribute to NIHL at Chibuluma mines Plc?
- (ii) How many miners have developed NIHL at Chibuluma mine Plc?
- (ii) What are the hearing protection programs and policies that have been developed by management to protect miners from developing NIHL?
- (v) To what extent are the workers adhering to hearing protection policies and regulations put in place by management?

1.7 Definition of key terms

Noise: It is an unwanted sound that cause psychological, physiological and social effects, a feeling of disturbance, stress reactions sleep disorders, some hormonal changes, increased blood pressure, changes in myocardial infarction, impairment of wellbeing, and negative impact on the general quality of life.

Noise Induced Hearing Loss: The acquired loss of hearing that occurs due to excessive noise exposure (Acutt and Hatting, 2009).

Employee: Any person who in any manner assists in carrying or conducting the business of the employer (Acutt and Hatting, 2009).

Factors: Facts or situations that influence the results of something (Oxford dictionary, 2012).

Contribute: To help cause something (Oxford dictionary, 2012).

Audiogram: A graph of hearing sensitivity in which various tests frequencies are plotted on the horizontal axis from 250 Hz to 800 Hz with the vertical axis showing the degree of hearing loss in decibels (Workplace safety and insurance board).

Hearing Conservation Programme: The program that coordinates activities with noise control and prevention.

CHAPTER TWO: LITERATURE REVIEW

Overview

A literature review in this study is a survey of scholarly sources on a specific topic. It provides an overview of current knowledge, allowing the researcher to identify relevant theories, methods, and gaps in the existing research that you can later apply to your paper, thesis, Macombes,(2023).

2.1 Noise induced hearing loss

According to (Shemesh, (2010), hearing loss is the gradual decrease in sensitivity to sound or inability to hear sounds, either partially or totally. WHO, (2015) reviewed that excessive repeated exposure to noise and a single exposure to an extremely intense sound may cause damage to the auditory system and result in hearing loss. It further reviewed that hearing loss is gradually during the onset but progresses relentlessly for as long as the exposure continues. The harmful effect of noise exposure may manifest long after the exposure has ceased.

Shemesh, (2010), furthers stresses that when describing hearing impairment, three attributes are considered, type of hearing loss, degree of hearing loss and configuration (range of pitches or frequencies) at which the loss has occurred.

The American Speech Language Hearing Association (2014), categorizes hearing loss in three different groups based on the part of the auditory system affected, namely conductive, sensorineural and mixed hearing loss. Conductive hearing loss occurs when sound is not efficiently through the alter ear canal to the eardrum and the tiny bones of the middle ear. In this type of hearing loss, the damage can often be reversed with interventions, including surgery. The most common type of hearing loss is sensorineural which results from the damage to the microscopic hair cells of the inner ear involved in conveying sound waves into the nerve impulses that humans perceive as sounds (American Speech Language Hearing Association, 2014).

WHO, (2015) argued that sensorineural hearing loss can be temporal or permanent, and is usually bilateral and non-reversible. Ting Su and Koh, 2014 added that permanent hearing loss results from regular and prolonged noise exposure, which causes gradual, irreversible damage to the sensory cells and other structures.

According to Timmins and Granger, (2013) exposure to loud noises from all sources accounts for about 20 percent of adult on-set hearing loss, although some research suggests that this proportion

may be considerably higher. About 75 percent of moderate or greater hearing loss worldwide is adult onset.

Chronic exposure and repetitive exposure to high intensity noise and long duration of contact with noise than 85 dB may aggravate the development this occupational disease (Sayapath, Ting Su and Koh, 2016).

2.2. Socio-demographic factors affecting noise induced hearing loss

Socio-demographic factors affecting NIHL Many factors may influence hearing loss; including age, gender, education, marital status. Age, also called age-related hearing loss or presbycusis results from degeneration of the inner ear structure occurs over a period of time, hence it comes gradually. Most people lose hearing at middle age which worsens at old age (Reshman, 2008) due to the damage of hair cells within the cochlea, hence ineffective transmission of signals (Mathew et al., 2003). Gender influences development of sensorineural hearing impairment; male gender is the most affected by NIHL (Minja, 2003). NIDCD, (2018) suggested that men are twice likely to experience hearing loss than women. Men have a higher noise exposure due to their high percentages in noisy environment (Golz, 2001), genetically predisposed to NIHL (Gao et al., 2020) Education level is one of the most important factors to personal success in society today (Clemson, 2014). Most educated people are less effects by work place hazards. A lower risk was observed for workers with some education (Boini et al., 2017). This is because educated people tend to make better decisions, hence a safe work place (Salem et al., 2010). The culture of safety is influenced greatly by the behavior and attitude of workers. The cultural theory of risk, indicates that people tend to perceive danger and respond 19 to risk in different ways and that these different ways tend to encourage the development of different social structures (Rayner, 2009). A health and safety culture is key factor when it comes to determining the effectiveness of a safety system. Culture is based on behavior, every day actions, and decisions and goes far beyond health and safety policies (Sawanga, 2016). Head trauma that can be caused by accident or head injury leads to traumatic brain injury which can lead to hearing loss due to injury of auditory path way (Chiasson, 2015). After head injury, eardrum or ossicular chain damage may occur which interferes with intralabyrinthine fluid and nerve, hence hearing loss (Timothy et al., 2021). Sudden deafness has been associated with viral diseases such as mumps, rubella, the respiratory and herpes groups of viruses, and hantavirus and Lassa virus (Pitkaranta, 1999). The inner ear structure can be damaged

by viral infection or increase susceptibility to bacterial infection which leads to hearing loss (Cohen, 2014). Inherited hearing loss is classified as autosomal recessive from X-linked or dominant which is mitochondrial-related. The autosomal recessive hearing loss is caused by pathogenic variants in both alleles where the child inherits them from both parents. Autosomal dominant inheritance occurs when variants in one single allele are able to cause hearing loss (Moza et al., 2019). Genetic inheritance may run in the family and occur due to change in the inner ear and auditory nerve (NIDCD, 2018) about 80% of deafness is genetic (Shearer, 2017)

2.3. Predisposing factors to Noise Induced Hearing Loss

Predisposing factors to NIHL NIHL can be caused by a one-time exposure to an intense “impulse” sound, such as an explosion, or by continuous exposure to loud sounds over an extended period of time, such as noise generated in a workshop. (NIDCD, 2010). Genetic factors may make some individuals more susceptible (P Yu et al., 2018, T Dinget al., 2019). Other things that have been linked with an increased risk of noise induced hearing loss include smoking (Guo et al., 2017, Tavana et al., 2017), male gender, race, poor diet, diabetes, cardiovascular disease (Carrol et al, 2017).

2.4. Frequency

Frequency Pitch is measured in frequency of sound vibrations per second, called Hertz (Hz). Frequency is measured in cycles per second, or Hertz (Hz). The higher the pitch of the sound, the higher the frequency. A low pitch such as a deep voice or a tuba makes fewer vibrations per second than a high voice or violin. Generally, noise induce hearing loss occurs at a pitch of about 2000-4000 Hz (American Hearing Research Foundation, 2012). Frequency is measured in cycles per second, or Hertz (Hz). Young children, who generally have the best hearing, can often distinguish sounds from about 20 Hz, such as the lowest note on a large pipe organ, to 20,000 Hz, such as the high shrill of a dog whistle that many people are unable to hear (Ambrose, 2003). Human speech, which ranges from 300 to 4,000 Hz, sounds louder to most people than noises at very high or very low frequencies (Meyer, 2020). There is considerable variation in the hearing range between individuals. Most young people can hear up to 18,000 Hz. Our ability to hear high frequencies declines with age. By the age of 55, some men can't hear above 5,000 Hz and some women can't hear above 12,000 Hz. Women tend to have better hearing than men at high frequencies (Homans,2017). When hearing impairment begins, the high frequencies are often lost first, which is why people with hearing loss often have difficulty hearing the highpitched voices of women and

children. Hearing impaired people often have difficulty detecting differences between certain words that sound alike, especially words that contain S, F, SH, CH, H, or soft C, sounds, because the sound of these consonant is in a much higher frequency range than vowels and other consonants (American hearing research Foundation, 2012).

2.5. Duration

The duration (how long you are exposed to a noise) can affect the extent of noise induced hearing loss. The longer one is exposed to a loud noise, the more damaging it may be. Excessive noise is present in many situations for instance; every gunshot produces a noise that could damage the ears of anyone in close hearing range 18 (American Academy of Otolaryngology, 2005). Large bore guns and artillery are the worst because they are the loudest (Jacob, 2012). Even cap guns and firecrackers can damage your hearing if the explosion is close to the ear (American hearing Foundation 2012). According to the American Hearing Research Foundation (2012). Anyone who uses firearms without some form of ear protection risks hearing loss. Some of the more common situations of excessive noise include occupational noise (machinery, among others), loud music, and non-occupational noise (such as lawn mowers, snow blowers, among others).

2.6. Industries that produce excess noise

A more specific discussion about the gold mining industry is indicated at this point. The theoretical concepts and existing knowledge about NIHL have been well documented for a number of different industry types. These include cotton and jute weavers (Robinson, 2002); forest workers (Robinson, 1999); hydroelectric power plant workers (Celik, 2007); coal miners (Spies, 1999); platinum miners (Nairn, 2001); automobile metal pressing plant workers (Tormalm, 2001) and railway workers (Henderson & Saunders, 1998). The gold mining industry has specific attributes that could impact on the characteristics of the NIHL found in gold miners. These include the fact that the working environment can be up to two kilometers underground and up to ten kilometers into the mine on a vertical plane. Here, miners work on the rock face for many hours a day, often exceeding the usual 8 hour working day, in the presence of high levels of noise from machinery such as drilling equipment, ventilation equipment and transportation equipment, in confined areas which may also impact on the acoustical effects that the noise has on the workers (Smith and Hodgson, 2003). Noise exposure levels associated with various job types in the South African gold mining environment have been documented as far exceeding the legislated level of 85dBA (Kielblock, 2000). The research organization of the Chamber of Mines has reported (Schroeder,

2006) that underground and surface mining equipment such as jackhammers, pneumatic drills, ball mills, air compressors, drilling equipment, stopping and developing equipment and equipment for bending, riveting, grinding and cutting steel plate, are known to emit noise levels of up to 120 dBA. Recent research in South Africa has resulted in updated and comprehensive knowledge about the intensities and spectrum of the noise to which miners in South Africa are exposed, and comprehensive information for conservation programmes is now available (Franz et al. 2004). This extensive research into the emission levels and spectrum of noise in mining environments showed that “all production personnel are at considerable risk with regard to noise exposure” and “noise emission levels and particularly worker exposure levels in conventional gold and platinum mining appear to have increased” (Franz et al 1997:131), due to the need for increased productivity. These circumstances will of course impact on the hearing of workers have noted that although their research results were based on constraints applying to platinum miners, gold miners were expected to have similar results. They found that only 2-3% of platinum miners exhibited binaural hearing impairment (BHI) higher than 25 %, while 10% of drill operators or their assistants fell into this category. As mentioned earlier, high temperatures, physical exercise and toxins may all influence the escalation of NIHL and these are also factors present in the deep gold mining environment. The preceding discussion implies that the deep gold mining environment will result in specific characteristics in the NIHL.

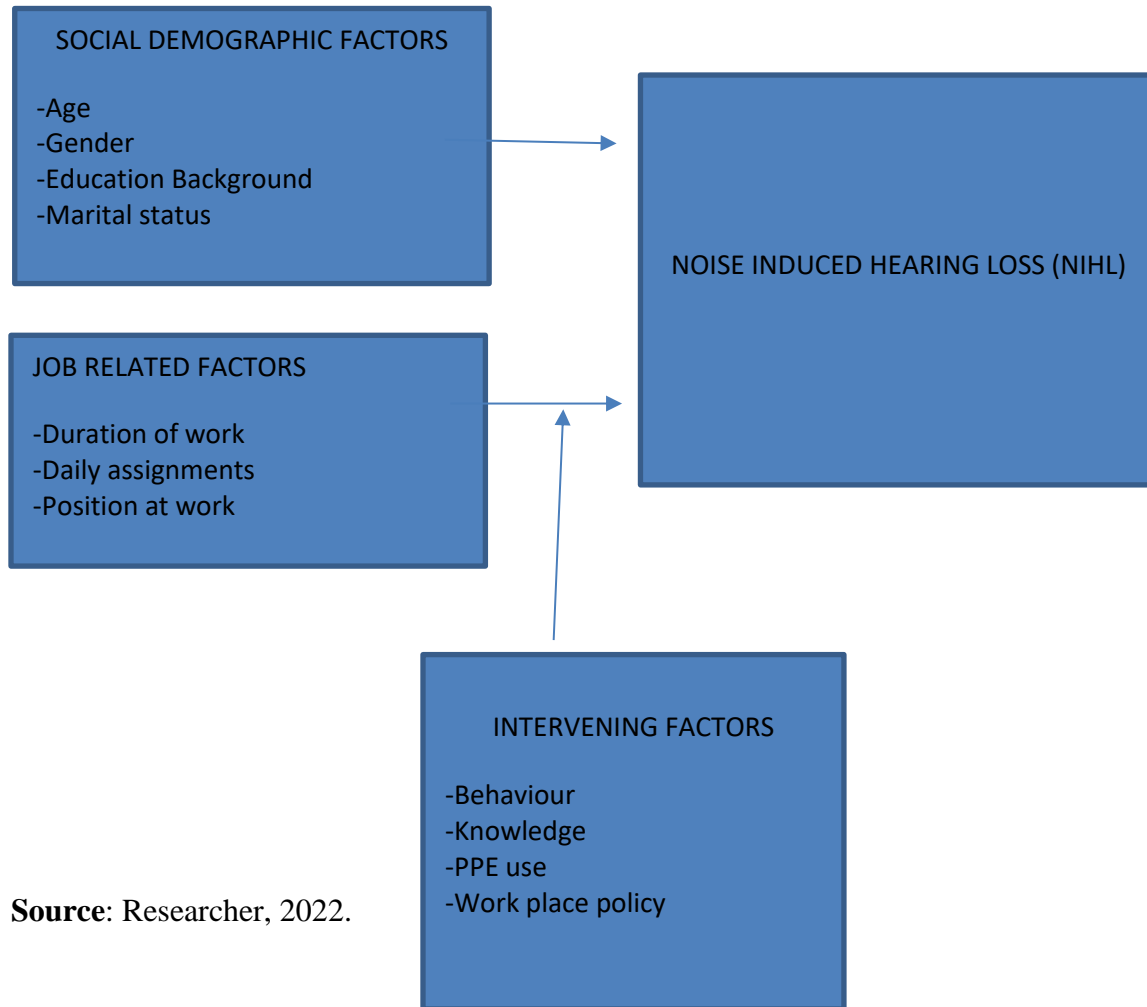
2.7. THEORETICAL FRAMEWORK

According to the ecological model of health behaviors (McLeroy et al., 2000), health behaviors are influenced by five separate sources: (1) intrapersonal factors; (2) interpersonal processes and primary groups; (3) institutional factors; (4) community factors; and (5) public policy (Sallis et al., 2015). The ecological model of health behaviors provides a framework to bring together behavioral, social, policy, and, importantly, biological aspects of the human experience into an epidemiological study. The model suggests that the interaction between these various influences should be considered when developing a public health intervention (Ehrman, Gordon, Visich, & Keteyian, 2009; Thurston, 2013). As with other ecological models of health behavior, social and psychological influences are incorporated into the model while environmental and policy aspects of behavior are emphasized (Sallis et al., 2015). By their very nature, ecological models ensure the

consideration of different levels of influence, both individually and interactively. Thus, they allow for comprehensive interventions to be developed and implemented. Ecological models conclude that it takes both individual-level and policy/environmental-level interactions to obtain significant change in behavior. As occupational NIHL can be thought of as the result of individual behavior and company/government policies, the ecological model of health behavior will be used as the theoretical framework for this study.

2.8. CONCEPTUAL FRAMEWORK

It is a sketched representation of the research variables relationship, the dependent variable being hearing loss NIHL, independent variable being socio-demographic and work-related factors, intervening factors in this research were use of PPE, and Noise levels.



Source: Researcher, 2022.

CHAPTER THREE: RESEARCH METHODOLOGY

OVERVIEW

3.1. RESEARH APPROACH

A qualitative research approach was used to conduct this study. A qualitative research methodology is concerned with meanings, attitudes and behaviors best understood within their natural settings (Babbie and mouton, 2011). Since the objective of the study was to explore and describe the factors that contribute to NIHL, semi structured one on one was conducted to enable the researcher to acquire in depth understanding of the factors that contribute to NIHL. This was followed by asking probing questions to obtain more information.

3.2. RESEARCH DESIGN

This is an exploratory and phenomenological study design will employ a qualitative approach of data collection. Qualitative study is a process of naturalistic inquiry that seeks an in depth understanding of social phenomena within their natural setting. Phenomenology is concerned with peoples lived experiences (Creswell, 2013). In this study the phenomenon is noise and the workers were asked to relate their lives experiences with regard to noise exposure at their workplace, which might cause NIHL. Through a descriptive and contextual design, the participants were asked to describe the factors that contribute NIHL as they occur at Chibuluma Mine Plc.

3.3. STUDY SITE

The study research was conducted at Chibuluma mine Plc in Kalulushi, Copperbelt Province. Chibuluma mine is 12 Km from the City of Kalulushi. At this mine all the employees are exposed to noise on a daily basis. Arising from the workers complaints, the researcher found it imperative to conduct this study in order to investigate factors leading to workers being exposed to excessive noise.

3.4. STUDY POPULATION

The population was the entire group of persons or subjects that met the criteria that the researcher was interested in (Brink and van reensburg, 2012). Chibuluma mine Plc has a total workforce of 980 which is a breakdown of males 600 and females 380. The population for this study consisted of 20 employees that were exposed to noise at the workplace.

3.5. SAMPLING PROCEDURE

A purposive and convenience sampling was used to select the participants in this study. Therefore, interviews, observation, documentation and virtual materials were used to collect data. Probing questions were asked to follow up, seek clarity and obtain more information through an interview guide. All the interviews were captured on a voice recorder and field notes were taken on observable behaviors.

3.5.1. Purposive sampling

During purposive sampling the researcher used his knowledge about the population to select relevant sample members with knowledge about the problem being studied (Polit and Beck, 2012).

Neuman (2011), argue that purposive sampling is based on the researchers' judgement or on selected cases with a specific purpose in mind as the sample is composed of elements that contain the most representative characteristics or typical attributes of the population.

3.5.2. Convenience sampling

Convenience sampling involves people already available for the study (Brink et al, 2012). The researcher explained the aim of the study to the mine management. The research in conjunction with the mine management made use of the spread sheet with the names of employees diagnosed with NIHL in 2021 at the mine clinic to select the employees for the study. **A maximum of 20 employees were selected on their availability and consent to participate in the study.** This sample size was used because when interviewing a distinct segment of participants, a researcher was able to explore all of the common themes the sample set had in common. In other words, after doing, about 15 interviews about the topic, the researcher started getting similar responses from the participants all say similar things hence saturation was reached.

3.6. DATA COLLECTION PROCEDURE

Data was collected by the researcher for a period of one month. The researcher started by collecting demographic data to put employees at ease, to create rapport and to understand the social background. Semi-structured one on one interviews using an interview guide. The interviews were done using languages that are spoken and understood by the participants at Chibuluma Mine Plc which are Bemba, Lamba and English. The interview guide was used to collect more information, probing questions were asked to gain more explanation, gain a better understanding and a follow-on interesting information regarding factors leading to NIHL. All the interviews were captured on a voice recorder. The interviewer got permission to record all the interviews. The field notes were being captured on non-verbal communication such as mannerisms displayed by the participants. Field note were analyzed together with the verbatim transcriptions to develop themes and sub-themes. The participants were allowed to describe their situation freely without any interruption. The physical or the psychological effects of the interviews were monitored to avoid signs of distress. Data was collected until saturation is reached, were no new information emerged.

3.7. DATA ANALYSIS

Thematic analysis, which comprises of eight integrated methods, was used in this research study (Creswell, 2009). The eight steps of Techs coding method was used to transcribe the data which involves eight steps.

The researcher got sense of the research as a whole by reading through the transcriptions of each interview carefully and jotting down ideas as they come.

The researcher analyzed the transcriptions of the interviews and field notes that were taken during the interview and selected those that were more interesting.

The researcher compiled a list of topics, similar topics were clustered and formed into columns. This were arranged into major topics. Unique topics and irrelevant issues.

The researcher then abbreviated topics as codes and write them to the appropriate segment of text. This was done to establish whether new categories of codes would emerge.

The researcher then reduced the total list of categories by grouping together the topics that are related to each other.

The researcher then decided on the abbreviations for each code and arranged them alphabetically. Data belonging to each category was assembled on one place and a preliminary data analysis was performed.

Finally, data was grouped in themes and sub-themes.

3.8. RELIABILITY AND VALIDITY

Reliability and validity are concepts used to evaluate the quality of research. They indicate how well a method, technique or test measures something. Reliability is about the consistency of a measure. Validity in a qualitative research means appropriateness of the tools, process and data. However, the essence of reliability for qualitative research study lies with consistency.

3.9. ETHICAL CONSIDERATION

De Vos et al (2011), describes ethics as a set of moral principles that are suggested by an individual or group, which offers rules and behavioral expectations. Leedy and armrod (2010), argue that whenever human beings or creatures with the potential to think, feel and experience physical or psychological distress are the focus of investigation, the researcher need to be sensitive to ethical issues in order to ensure correct conduct. Due to the fact that human beings participated in this study, the following ethical standards were adhered to: permission to conduct the study, informed consent, confidentiality and anonymity, principle of justice and principle of non-maleficence.

An informed consent sheet was developed by the researcher and it was distributed to study participants to provide their consent, that is, to agree or not agree to be part of the study. In some cases in order to protect confidentiality anonymous data was collected.

CHAPTER FOUR: PRESENTATION OF RESULTS AND DATA ANALYSIS

4.1. INTRODUCTION

This chapter presents the results of the data collected from the employees who were being exposed to noise at Chibuluma mine Plc. The demographic characteristics of the participants are outlined in Table 4.1. Teschs inductive and descriptive coding technique was adopted for data analysis, as suggested by Creswell (2009). Themes and sub-themes emerged during data analysis. The results are discussed based on factors contributing to noise induced hearing loss among miners at Chibuluma mine plc in Kalulushi district, Copperbelt Province.

A total number of 20 employees were interviewed until data saturation was reached. In this study, employees were identified as participants.

Table 1 Demographic characteristics of participants (employees exposed to noise).

Gender	Age in years	Occupation	Period of employment	No of decibel exposed	Baseline percentage of hearing loss	Percentage of hearing loss
Males-18	21-30=6	Winch operator-3	0-15=10	85dB and below=3	0-5%=2	10-20%=14
	31-40=9	Rock drill operator-14	16-25=6	85-95dB=12	6-10%=12	21-30%=4
	41-50=3	Change house attendant-1	26-35=2	96-105dB=3	11-20%=4	
Females-2	21-30=1	Change house attendant-1	0-15=1	85dB and below-1	0-5%=1	10-20%=1
	31-40=1	Occupational hygiene-1	16-25-1	85-95=1	6-10=1	21-30%=1

THEMES AND SUB-THEMES

Flick (2014) describes a theme as an umbrella construct relevant to the research question, which can be seen on some level of patterned response or meaning within the data set. A sub-theme is a specific theme within a large theme (Flick, 2014). In this study four themes and there sub-themes emerged during data analysis as outlined in table 4.2. The themes and their sub-themes are discussed below. Direct quotes from the participants are presented to support the study findings. Literature is also presented to support the findings.

Table.2: Summary of themes and sub-themes reflecting the factors contributing to NIHL.

THEMES	SUB-THEMES
Noise hazards and the health of employees	1.1.Hearing loss acquired in the line of duty 1.2.Knowledge related to source of noise and the prevention of NIHL.

	1.3. Employee's perception of noise.
Experiences and challenges faced by employees in the work environment.	2.1. The existence of noise 2.2. implementation of screening tests 2.3. Maintenance and repair of faulty equipment.
The hearing device protective factors	3.1. Availability and quality 3.2. Knowledge and adherence 3.3. Replacement process
Management and leadership factors	4.1. Enforcement and implementation of policies, guidelines and regulations. 4.2. precautions taken to minimize noise hazards 4.3. Education health programs for noise control 4.4. Recommendations to employees following NIHL.

THEME 1: NOISE HAZARDS AND THE HEALTH OF EMPLOYEES

Noise is unwanted sound that degrades the quality of life and contributes to several health hazard. It affects human being physically, psychologically and physiologically (Fasae, 2015). The most common health hazard is hearing loss, which occurs gradually, and can be temporary, or irreversible or permanent (Akinkuade, 2016). The following sub-themes emerged from this theme:

Theme	Sub-themes
Noise hazards and the health of employees	1.1. Hearing loss acquired in the line of duty 1.2. Noise related to the prevention of noise and prevention of NIHL. 1.3. Employee's perception of noise.

Sub-theme: Hearing loss acquired in the line of duty

Exposure to high levels of noise has both auditory and non-auditory negative health effects on employees. These effects do not only affect them but also affect how they relate with others and can cause disability (deafness) (Shemesh, 2014). In this study the participants reported that their present hearing status, which is poor, was caused by noise they have been exposed to in their working environment. This was supported by a participant who said:

“I think the reason why I cannot hear well is because of the noise from the machines. I have been working with machines for a long time, I also think it is their time not to hear well (the ears), you can see am getting old. Most of the people here who have hearing problems it’s us the old ones, the young one do not experience much of such problems. I think also because of years ago when we started work the mines did not have hearing protective devices.”

Another participant said:

“Eehhhee (changing facial expression and moving close to the interviewer) I think my ears were damaged by the work that I was doing. I used to work as a winch operator before they moved me to canteen supervisor because my ears were damaged. I have worked as a winch operator for many years and those machines make a lot of noise. The machines am referring to are the fans and drilling machines, even today I cannot hear well because of the noise from those machines.”

A study by Ware, (2016) on the epidemiology, mechanisms and interventions on human hearing loss revealed that prolonged high-intensity noise exposure in the work place can damage hearing cells, producing a permanent hearing threshold shift and reduced speech from noise distinction. Ware, (2016) further outlined that the main impacts of hearing loss is the reduction in ability to communicate with others, which affects them in all aspects of their lives (socially, emotionally and economically). Edwards, (2014) reported that excessive noise exposure can lead to permanent hearing loss and poor verbal communication which leads to social isolation and disruption of lives.

Sub-theme 2.2: Knowledge related to source of noise and the prevention of NIHL.

According to Azman et al, (2013) insight and knowledge of employees on the source of noise and the available preventive measures can result in more positive attitudes towards participation and compliance on noise control and hearing loss prevention. In this study participants seem to be

knowledgeable about the source of noise in their different work areas. The findings are supported by the following extracts:

“I think now it’s better because they used to blast when we had no protective hearing devices. The noise which was coming from the blasting of rocks used to be too much, but currently they only blast when we are in protective gear or when everybody has knock-off. The other thing is that as employees we must take responsibility of using ear plugs and know that if you are not using them you are killing yourself.”

Another participant said:

“There is noise from the drilling machine because when you bore it, it is not possible that the machine cannot make noise. I cannot lie they tell us every day before we start work about protecting our ears and they give us personalized ear plugs.”

Another participant said:

In the mining industry there is a lot of machinery and a lot of them release sound pressure which contribute to NIHL. For example here there is haulages, fans, compressors, rock drill and winches. In those machines they are silencers which reduce the noise. The other thing is noise exposure time is not adequate, sometimes employees exceed 8 hours working in noise environments.

The results of this study agree with the study done by Nthakana (2014) on the knowledge, attitude and views of South African mine workers regarding noise induced hearing loss and the use of protective hearing devices in gold and non-ferrous mining industries. The participants agreed having knowledge on the sources of noise. They further demonstrated that drilling and ventilation machines, diesel operated winches and crushers produce the highest level of noise in the workplace. The study by Nthakana (2014) also revealed that the participants displayed knowledge on the preventative measures for deafness, such as proper use of protective hearing devices when using noise machines. A study by Azizi (2012) revealed that different equipment used in coal primary plants were the loudest source of noise production.

Sub-theme 2.3. Employee’s perception of noise

Participants seem to view noise as normal and part of their daily working life, as reflected in the following verbatim statements:

“In the working environment when you bore it, it’s not possible that the machine will not make noise, it will make noise continuously. There are also other machines that make a lot of noise like fans, winch and compressors.”

In addition, another participant said:

“In the mine there is a lot of noise from the machines that we are using, so it is not possible that you can prevent noise, the noise has been there for long time since I started to work in the mines even now it is still there.”

THEME 2: EXPERIENCES AND CHALLENGES FACED BY EMPLOYEES IN THE WORK ENVIRONMENT

Although mining has an economic, labour and social effects in our country, it is a demanding environment where employees are faced with a number of challenges such as excessive noise, which has a negative impact on their health, social life, families, the community and the society surrounding them (Ware, 2014). Participants shared their views on the challenges that emerged in the following sub-themes:

Theme	Sub-themes
Experiences and challenges faced by employees in the work environment.	1.1. The existence of noise 1.2. implementation of screening tests 1.3. Maintenance and repair of faulty equipment

Sub-theme 1.1: The existence of noise

The participants shared similar views on the existence of noise in their work environment, which was perceived as the cause of their hearing problems. This is reflected in the following extracts from a participant who said:

“Am working as a rock driller and there is a lot of noise coming from the machine that we use to drill and from the fans. This noise is there every day and I have been working in this environment since 2001. Even now I cannot hear well because of the same noise.”

In addition, another participant said:

“In the mining environment there is a lot of noise coming from the machines which emit a lot of noise. The other things especially in the mining environment can be like the difference in sound pressure levels, like when you are in the cages. When we go down underground with a cage (lift) the pressure increases the level of noise and when you get out you have temporary hearing loss.”

The findings are in agreement with the study conducted by Ameratunga (2012) on the use of hearing protection in manufacturing workers. They reported the existence of constant noise in the workplace as the main cause of hearing problems such as hearing loss. Horris and Cox carried out a study on the impact of social and psychosocial risk on employee well-being and quality of life in the mining industry of Ghana. Their study indicated that outrageous noise created by machines used in the mines increased the likelihood of hearing loss. Strauss (2012) outlined that mining of minerals is associated with excessive noise due to the use of machines which involves grueling and forceful task.

Sub-theme: 1.2. Implementation of screening tests

One of the ways to assess the effectiveness of preventative noise control measures and to detect and monitor hearing loss overtime is to assess workers hearing through conduction of audiometric test (SANS, 2013). It is also a legislated requirement that the employer must comply with DME (2003) guidelines. The audiometric tests must include pre-employment (baseline) periodic and exit audiograms. Findings of this study revealed that audiometric screening tests such as baseline, periodic and exit are being conducted.

One participant said.

“They check us in the clinic and test us, they also check our lungs. I mean they test our ears in the machine every year when we come back from leave you cannot go back to work without first going to the clinic they will return you back from the shaft”

This study concur with the findings conducted by Renton and Wilson (2014) in the iron and steel industry in South Africa, in eight companies. They reported that all companies had medical surveillance programmes in form of audiometric testing at baseline periodically and at exit medical assessment. In support of these findings, the Mine Health and Safety Act (1996) indicate that audiometric screening tests must be done during employment, annually and when the employees leave the company. Thakana (2014) reported that medical examinations which included audiometric test and the audiometric assessment were done to all the employees when they return from leave.

Sub-theme: Maintenance and repair of faulty equipment.

Engineering control is one of the essential components of noise management programs. This means control of noise from the source which means buying of quieter machinery, replacement and maintenance of machinery (workplace safety and health guidelines, 2014). With regards to the aforementioned statement, participants indicated that there are policies in line with maintenance and repair of machines. This statement is supported by the following extract from one of the participants:

“The machines are serviced by the manufacturing companies quarterly. If there is any breakdown manufacturers are called to come and fix them. We also have a police in place on the service and maintenance where they check if the silencers in the machines are working effectively. We also have a responsibility as employees to check the machines before the beginning of every shift and should there be a problem we immediately report to managers”.

Another participant said:

“The cage makes a lot of noise if the pipes inside are in good condition. A cage is something like an elevator which transports us to underground and inside there are pipes for smoke. The pipes sometimes are broken and they make a lot of noise like waaa”

Occupational safety and health administration (2016) indicate that proper maintenance of equipment and replacing faulty or worn out one can significantly reduce noise at the work site. The study done by Kulkarni (2016) in reviewing the effects, monitoring and control of pollution revealed that there was poor implementation of technical measures such as maintenance of roads, vehicles and machines.

THEME 3: THE HEARING PROTECTIVE DEVICE FACTORS

The last essential component of the hierarchy of control of noise is the provision and use of hearing protective devices which was enforced in South African mining industry in 1988 and became compulsory for all mines (Guild et al, 2010). The following sub-themes emerged from this theme:

Theme	Sub-theme
The hearing protective device factors	3.1. Availability and quality 3.2. Knowledge and adherence 3.3. Replacement process

Sub-theme 3.1: availability and quality of hearing and protective devices

In this study, participants acknowledged that presently they are being provided with different protective devices, such as personal protective hearing devices, custom made noise (x), disposable ear plugs and ear muffs. They also raised some concerns that the personalized hearing plugs were introduced late to them when their hearing ability was already compromised. The quality of custom made devices was found to be questionable. This is reflected in the following extracts from the participants:

“Now they provide us with different hearing protective devices, am using the custom made personal ones (they measure our ears and fit them) before they give us and they protect our ears

better than the other ones. The roll out is not 100% complete, some are still using the old protective devices such as disposable ear plugs and ear muffs we are available in our stores”.

The other participant said:

“We are now using customized protective hearing devices which are called noise x. They are actually giving much protection than the plastic ones. The other good thing about noise x is that they are personalized, even when they are lost no one can wear another person’s protective devices, it is only the owner who can use them”.

In support of this study Nthakana (2016) reported that South African mine workers indicated that they preferred custom made ones which are called noise x because they protect the ears more efficiently. A study by steenkamp (2008) on personal approach to hearing conservation report that personal, custom made hearing protection devices have more advantages as they are physically comfortable. They provide enough attenuation for the specific working zone and over protection is minimized to optimize communication so that employees can hear warning signals, work place safety guidelines (2017) outline that employees who are exposed to excessive noise should be provided with suitable hearing proactive devices which must be suitable to their working environment and the type of job involved.

Sub-theme 3.2: Knowledge and adherence

Hearing protection devices are designed to additional protection to engineering and administrative controls, which ensure that the exposed employees are adequately protected from the excessive noise (workplace safety and health guidelines, 2015). barriers such as lack of knowledge, might contribute to poor adherence. In this study the participants seem to have knowledge about the importance of using hearing protective devices in their work places. This was confirmed by the following statements from the participants:

“We only use ear plugs to protect our ears from the noise. There is nothing else that am using. I only know the rubber ear plugs and the personalized noise x which are issued to us to protect our ears when we go underground”.

Additionally another participant said: *“nodding, they give us different ear plugs like noise bans and ear plugs, you cannot operate any machine without the hearing protection devices. Should the supervisor or safety officers find you operating a machine without hearing protection device, they stop you and take you to the office, they are very strict”*.

In the study by Nthakana, (2014), all participants regardless of their experience were aware of the importance of using hearing protection devices for the whole shift and owned personal hearing protective devices. Nthakana, (2014), revealed that even though participants were knowledgeable about the use of hearing protection devices they seemed to ignorant about other hearing protection devices which are practiced by the mine. Reddy et al, (2017) reported that employees are knowledgeable that the hearing protective devices protect their ears from damage.

Sub-theme 3.3: replacement process

Eventualities such as the replacement of damaged hearing protection devices can compromise the hearing of employees if not well managed. The participants revealed that the replacement of broken hearing protection devices is a challenge as they take long to repair them. The following extracts from the participants support the statement above:

“If you report that the noise ban is broken, they take them for repair to the clinic. The problem is that after they take them for repair they take us back to work without them. What I mean is that when they say let us go back to work they must give us plastic ear plugs so we can use them, for now they just let us go without saying anything, but we the old ones we go our supervisors who take us to the store room to collect plastic ones. If it is a new person they just go maybe a month working with ear plugs and when the ear plugs come back the ear are already damaged”.

Another participant said: *“eehee if the noise bans are broken they must provide us with temporary ear plugs. Because they take more than a month to fix the old ones”*.

In agreement with these findings, the study by Bluek, (2017), inadequate provision and replacement of damaged ear muffs was one of the barriers identified and experienced by the

participants. A study by Timmins, (2013), on overcoming barriers to effective noise control and hearing loss prevention in Australia, reported that some of the hearing protective devices used by workers got damaged due to misuse and being worn out.

THEME 4: MANAGEMENT AND LEADERSHIP

Mining leaders and managers are guided by the Mine Health and safety Act, (MHSA Act no. 29 of 1996) which stipulates employer specific obligations regarding noise in order to protect the health safety of employees. Management commitment is the most important factor governing achievements in hearing conservation. The following sub-themes emerged from this theme:

Theme	Sub-theme
Management and leadership	4.1. Enforcement and implementation of policies, guidelines and regulations. 4.2. precautions taken to minimize noise hazards 4.3. Education health programs for noise control 4.4. Recommendations to employees following NIHL.

Sub-theme 4.1: Enforcement and implementation of policies, guidelines and regulations.

The Zambian mining industry is regulated by legislation and guidelines and standards that regulate and guide all mines on the control and prevention of Noise Induced Hearing Loss. However, even though the regulations and guidelines are available the implementation can be challenging process for both the employee and the employer (Edwards, 2016). In this study the participants and the supervisors were in agreement that the mine had policies, guidelines and regulations were in place that were implemented through the hearing and conservation Programme. This programme guided the employee and the employer in relation to control and prevention of NIHL.

One participant said: *“We have NIHL investigation procedure available and code of conduct which is like a constitution to guide us the employees on how to deal with the noise. We also have legislation guidelines, policies and operating procedures available for different departments.”*

“One of the participants said: the contents of the hearing control program include: risk assessment and occupational hygiene monitoring, noise control engineering, education and training, medical surveillance, which include audiometric tests, investigation of hearing loss, hearing protection devices, availability and implementation of policies and guidelines in relation to noise prevention to the process of compensation and record keeping.”

The results of this study concur with the results of the study done by (Edwards et al, 2014), in relation to meeting the mile stones set by industry to prevent NIHL in SA. The findings revealed that these standards, legislations, guidelines and hearing conservation programme relating NIHL prevention are available, but there was poor compliance in their implementation within the mines. A study Edwards, (2016), on noise induced hearing loss milestones: past and future, revealed hearing conservation programme was an excellent way to coordinate activities with noise exposure control and prevention but a need for improvements to current program prevention strategies was identified.

Sub-theme 4.2: precautions taken to prevent noise hazards

One of management outlined that precautionary measures fall under the hearing conservation programme, which is the main umbrella were all activities for noise contro and prevention are implemented.

One participants said: *“management is implementing all the programs, we have the occupational hygiene and medicine, training center and couple of initiatives. Like we have quieter machines with noise silencers, we have hearing loss investigations and we have full time representatives available in all shafts. We are also issuing custom made hearing protection devices which have better protection. With all the initiatives that were introduced now it is up to the role player who is the employee to start using what is being provided to him.”*

On the same issue, Amponsah-Taiwan et al, (2017) highlighted that managerial support, initiatives to minimize hazards and the reinforcement of practices provided workers with social cues and enables employees to understand expectations about their behavior in relation to safety. The results also concur with MHS Act No 29 of 1996 which stipulates that the employer should take reasonable practice able steps to eliminate any measurable safety and health risk. Such risks include excessive noise from equipment and machinery and were it is reasonably practicable to eliminate the risk the option of replacing noise machinery with quieter ones should be considered.

Sub-theme 4.3: Educational health programme for noise control

Training and educational is one of the fundamental aspect of hearing conservational program. The current study revealed that the implementation of education and training programs was an important aspect in the safety of employees. This statement was support by the following response from the participants:

“When we go underground everyday there is some mass meeting were we talk about safety and protective devices and also our work material how we handle them. This is done to ensure that everything we do at work places is done according to standard. Even with rock drill machine when you operate you must follow the standards so that you don’t get injured.”

Additionally one participant said: *“we are being trained by our supervisors in different places by the accredited facility and in the clinic when we do medical initial and periodic. If when they do investigations and find that employees do not how to use hearing devices they re-train us.”*

In support of the findings of this study Reddy et al (2016) reported that regular training encourages workers to wear hearing devices and workers awareness of issues around noise and protection. The occupational safety and health Act of 83 OF 1996 stipulates that it is the duty of the employer to provide employees with hearing protective devices, training, instructions on noise control on employees who are exposed to noise below or above the rating limit of 85 dB.

“When an employee goes for audiometric test and the results come out greater than 5% the employee gets paraded and be investigated by the investigation committee. The investigations are done on a weekly basis every Thursday. The person investigate the person by asking questions on what could have caused the hearing loss, we re-train them on the use of hearing devices and make recommendations.”

Another addition the other participant said: *“in the investigation we try find out what happened, is he working in the noise environment and if not what are the contributing factors is actually making the supervisors know what is happening in the working environment and they try to help the employee.”*

The results of this study are being supported by Mizan et al (2015) were four companies reported that they conducted the investigations and re-trained the employees on early identification of hearing loss. They further revealed that the investigations also provided an opportunity to assess whether companies could translate policy intentions into good governance and practices.

Sub-theme 4.3: Recommendations to employees following NIHL.

The management and the participants revealed that part of the recommendations following noise induced hearing loss diagnosis depending on the extent of the illness, was redeployment from underground to a noise free area. This is supported by the following extracts.

“Am now working as a change house attendant and I only stopped working in winch machine underground the previous year when they moved me from underground. Where am working from now there is no noise but because of the hearing problem if after changing me I can still not hear very well.”

In support of this study, occupational health in gold sector (2015) indicate that employees diagnosed with NIHL should receive counselling and were possible they may be redeployed. The code of practice (2009) outlines that hearing impaired employees should be redeployed to noise free zones.

5.0 CHAPTER FIVE: DISCUSSION OF RESULTS

Theme 1: Experiences and challenges faced by employees in the work environment

The study reviewed that employees were faced with different challenges in their work environment. The challenges included the existence of noise hazards, implementation of screening tests and maintenance and repair of faulty equipment. Such challenges were perceived to be some of the contributing factors NIHL at Chibuluma Mine Plc.

The existence of excessive noise at the work environment was perceived as one of the many contributing factors. This was evidenced by participants indicating that exposure to noise from different machines, such as drillers, winch machines and from the farms, in their daily working environment might have contributed to their current hearing problems. These findings are in agreement with those findings by Edward et al (2011), who identified noise exposure as a widespread problem in the mining sector, due to use of heavy equipment, drilling, rock breaking, transferring, sorting and milling of rocks, as well as confined working environment. Implementation of audiometric screening tests, pre-employment, periodically and on exit, were identified as a positive initiative conducted by the mine to monitor the hearing status of employees as indicated in the occupational health Act.

Conducting regular ear tests for highly exposed employees is important for early identification of auditory damage and prevention of permanent hearing loss. Thus frequent auditory tests (e.g. every six months) may be needed if exposure is equal to or greater than 100 Db (SANS, 2013).

Participants in this study associated their current hearing status with poor maintenance of faulty equipment. They indicated that their work areas where noise is minimal below 85Dba like change house. However, due to recurrent malfunctioning of machines these areas end up being noisy. They also indicated that the pipes in the cage lift which transport them underground, emit a lot of noise if they are not functional.

Theme 2. Noise hazards and the health of employees

The present study indicated that excessive noise in the work environment is a health hazard and that a number of employees have acquired NIHL. This affected their safety and how they relate to other people, due to poor communication. This was evidenced by some of the participants indicating their inability to hear properly during their interview process by repeating words such as “Heee” resulting in the need for the researcher to repeat questions several times. Excessive noise exposure can lead to permanent hearing loss and poor verbal communication, which lead to social isolation and disruption of the lives of those impacted, as well as their families, friends and co-workers (Edwards, 2013).

The participants had insights and knowledge regarding sources of noise. They identified sources of noise, such as different machinery, blasting and fans, as some of the major sources of noise. A study conducted by Nthaihana (2014) indicated that participants displayed knowledge about the sources of noise. The rock drill, winch, loco machines, compressors and ventilation fans were identified as the main sources of noise Nthaihana (2014).

The current study indicated that some of the participants started to view noise as been normal and something that cannot be preventable. Hundak (2012) reported the belief that noise is difficult to control and that the perception of workers that they are used to noise might reduce their commitment and compliance to noise control and preventive measures.

Theme 3. The hearing protective devices found in this study were: availability and quality of hearing devices, knowledge of and adherence to regulations and guidelines and replacement process of HPDs. According to their experience these HPDs are more effective in terms of protecting their ears than the previous ones, which were ear plugs. However, the affected participants were concerned that the custom made devices were introduced too late, once their hearing had already been affected. They believe that if the custom made devices were introduced earlier, their hearing status would have been better.

The current study reviewed that participants had knowledge about the importance of and the use of HPDs. It was also reviewed that some of the employees only use them if they see safety officers and managers. A study by Musiba (2015) on the prevalence of NIHL among Tanzanian miners found that although employees were provided with HPDs compliance was poor.

The quality and replacement of HPDs (custom made) was identified as a problematic process that took long (almost a month). It was also reviewed that these HPDs were easily damaged.

Timmins (2010), reported that some of HPDs used by workers got damaged due to misuse and worn out.

Theme 4. Management and leadership factors

The present study indicated that enforcement and implementation of policies, guidelines and regulations: precautions taken to minimize noise hazards, educational health programs for noise control and recommendations to employees following NIHL, are some of the factors affecting leadership and management.

Although there were policies, guidelines and regulations available, the current study reviewed shortcomings in the implementation of some elements. These included conducting the proposed six months audiometric tests for high risk jobs and the proper maintenance and repair of faulty or worn out equipment. In India a study done by Kulkan (2015) reviewing the effects, monitoring and control of noise pollution identified the need for proper implementation of rules and regulations as one of the important strategies to overcome the burden of NIHL.

The present study revealed that training on the use and maintenance of HPDs and other health and safety issues were facilitated by the accredited facility and the relevant medical personnel in the training center and the clinic upon commencement of employment, annually and daily in different departments. Management also indicated that one of the methods used to train employees during hearing loss investigations by the HCP committee, was re-training of the affected employees on importance and use of HPDs.

However, management indicated that the content of the training should be more detailed and should include how hearing loss occurs. Employees should be made to understand that it occurs gradually and it is not revisable. It was further suggested that it will be effective if the sensitization starts from the top management and feeds down to employees in the lower level. In agreement with these findings Reddy et al, (2012) underline the raining must be intense a d stimulate an understanding that hearing is precious and that loss of hearing can affect different aspects of one

life. In addition there is need for public enlightenment, education and sensitization on the hazards, dangers and human health problems associated with noise pollution (Kulkan , 2015).

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

Noise-induced hearing loss may be caused by a single event, such as a loud explosion or gunshot. This type of NIHL can be immediate and permanent. In other instances, NIHL may be caused by exposure to loud noises over time. When this happens, you may go for weeks, months or even years before noticing symptoms, as they often occur gradually over time.

The results of this study indicated that noise induced hearing loss was caused by a combination of different contributory factors. Failure to comply the guidelines, policies and procedures from the department Mines and Mineral Development in full resulted in employees developing noise induced hearing loss. The employees also reported that the employer takes time to repair broken hearing protective devices.

Other factors included lack of hearing protective wear (PPE) to reduce the amount of exposure. Lack of proper management factors such as training on Noise and its impacts contributed to the significant number of NIHL cases.

6.2 RECOMMENDATIONS

The recommendations are given to enable mines and stakeholders, to revise the applications implementation and evaluation of all elements available in the legislations, guidelines and hearing programs for noise control and the prevention of noise induced hearing loss.

The following recommendations are based on four themes that have emerged during the one-on-one interviews with the employees at Chibuluma mine Plc.

6.2.1 Recommendations for theme 1: experiences and challenges faced by employees in the work environment.

The three sub-themes that emerged from this theme are: the existence of noise hazards, implementation of screening tests and maintenance and repair of faulty equipment.

6.2.2 Recommendation to management and practice

Management should enhance the hearing and conservation program as the main domain which coordinates activities to control and prevent NIHL in the mine. Therefore, the hearing and conservation program must constantly monitor and review the effectiveness of all elements in this program. This might help to identify gaps in the implementation of this program. Failure of the implementation of one element has an effect on the effectiveness of the whole program. It is necessary to identify, standardize and apply effective and efficient programs for the prevention and control of NIHL.

6.2.3 Recommendations for education and training and research

In-service training for both employees and management on the maintenance and repair of machines might encourage them to immediately report to the relevant department when they observe malfunctioning machines. Occupational NIHL is a major source of disability throughout the world. Therefore, public awareness campaigns, which addresses what noise is, risk factors, long term effects (physiological, social, psychological and economical), available preventive services and potential treatments, might assist to overcome the barrier of attitudes and beliefs (Ware, 2015).

There is a need for a training department to introduce a risk/hazard based program. This might equip employees with specific different hazards in the work environment depending on the occupation and adaptation of measures to prevent NIHL in those areas.

6.2.5 Recommendations for theme 2: noise hazards and the health of employees

Recommendations from this theme have emerged from the three sub-themes: hearing loss acquired in the line of study, knowledge related to sources of noise and prevention of NIHL.

6.2.6 Recommendations to management and practice.

It is recommended that there should be thorough explanation of the baseline audiogram results to all employees upon commencement of employment as they are used as reference for subsequent tests. The information given should be specific noise hazards in different occupations and should include the method employed to control these hazards.

6.2.9 Recommendation for theme 3: The hearing protective device factors

Recommendations related to this theme were based on the following three sub-themes which emerged from data collection. Availability and quality, knowledge and adherence and replacement process.

6.2.10 Recommendation to management and practice

More emphasis should be placed on adherence to the use of HPDs by encouraging the employees to take ownership of their health by involving them during training, meetings and in the clinic during medical examinations. This could be achieved through thorough explanation of their baseline audiogram as they are used as a reference for subsequent tests. However, the information given should be specific, should emphasize the specific noise hazards in different occupations and the methods employed to control these hazards.

The mine management should come up with strategies to evaluate and monitor whether the available procedures, guidelines and policies are well implemented. Ware (2015) suggested that adequate policy support structure and effective leadership may overcome the challenge of poor implementation of guidelines

6.2.13 Recommendations for them 4: management and leadership

The recommendations on this theme were based on the following sub-theme. Enforcement and implementation of policies, guidelines and regulations, precautions necessary to minimize hazards, educational health programs for control of noise and recommendation to employees regarding NIHL.

6.2.14 Recommendations to management and practice

The mine management should come up with strategies to evaluate and monitor whether the available procedures, guidelines and policies are well implemented. Ware (2015) suggested that adequate policy support structure and effective leadership may overcome the challenge of poor implementation of guidelines.

6.2.15 Recommendation to education and training

Revision of the available content of the training program for the employees at all levels, and awareness campaigns on noise should be implemented. This may help the employees to change their attitude and perception that noise is normal and part of working life.

The educational program provided on the use of HPDs need to go further than the fact that HPDs help to protect hearing. It should also emphasize the fact that hearing is precious and how hearing loss would affect different aspects of the employees' life. Employees with NIHL should be encouraged to form support groups to share their experience and coping strategies.

6.2.16 Recommendation to research

Further research should be undertaken to develop new strategies to address the needs of hearing impaired employees. This should be included in the HCP program, which may help to protect the remaining hearing.

Further research should be undertaken on the shortcoming to effective application and implementation of the Acts, guidelines, policies and procedures and should include the development of strategies to overcome shortcomings.

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Appendices

Appendix A. Interview Guide

Part 1. Demographic information.

1. Age.

18-28	1
28-38	2
39-48	3
49-58	4
59-65	5

2. High level of education

Never went to school	1
Primary school	2
High school	3
College	4
University	5

3. Occupation

Occupation hygienist	1
Shift boss	2
Team leader	3
Stopper	4
Driller	5
Mechanical	6
Milner	7
Local driver	8
Winch operator	9

Others (specify)	10
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4. Number of years employed

0-5	
6-15	
16-25	
26-35	
36-45	
46-above	

5. Number of decibels exposed to

85 and below	1
85-95	2
96-105	3
106 and above	4

PART 2 INTERVIEW GUIDE

What are the sources of noise at Chibuluma Mine Plc?

What do you think could have contributed to NIHL?

Describe the programs available at your workplace to address issue concerning NIHL?

What are the abatement measures has management put in place to protect workers from noise exposure at your work place?

Would you be in position to provide numbers related to those workers who have been diagnosed of deafness resulting from being exposed to excessive noise?

What do you think can be done to prevent continuous increase of NIHL at your work place?

4. WORK PLAN

October-November-Proposal writing and editing

November-December 2022- Proposal presentation and project registration at University of Lusaka

January-February – Application for permissions

February-April- Data collection/acquisition

April-May- Data analysis and drafting of final report

May-June- Completion of final report and Presentation of research outcomes

Gantt chart: Work plan for 2022/2023

	Month	Oct	Nov	Dec	Jan	Feb	April	May	June
S/N	Task								
1	Proposal writing and editing								
2	Proposal presentation and project registration								
3	Application for permissions								
4	Data collection/acquisition								
5	Data analysis and drafting of final report								
5	Completion of final report and presentation of research outcomes								

4.1. PROPOSED BUDGET

The researcher spent approximately K6, 800 in order to ensure successful completion of the research. The researcher oversaw all activities of the study including utilization of resources.

Stationery K1000

Meal Allowance K1000

Report writing K800

Transport K1000

Research assistants K2000

Contingency K1000.

Total – K6, 800

**SCHOOL OF MEDICINE AND HEALTH SCIENCES LEOPARDS
HILL CAMPUS**

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**SCHOOL OF MEDICINE AND HEALTH SCIENCES
RESEARCH ETHICS COMMITTEE**

Ref no: IORG0010092-2023/001

Date: 15th DECEMBER, 2022

ACKRIDE MULENGA – BSPH 1410191

Re: RESEARCH TITLE: AN INVESTIGATION INTO FACTORS CONTRIBUTING TO NOISE INDUCED HEARING LOSS AMONG MINERS AT CHIBULUMA MINE PLC IN KALLUSHI DISTRICT, COPPERBELT PROVINCE

The above research was submitted to the research ethics committee for review. The study has no major ethical problems and is approved subject to the following:

1. The study cannot be changed without express permission of the UNILUS Research ethics committee
2. Approval from the Lusaka District health Management or equivalent health authorities should be sought.
3. The study tools should be added.
4. An informed consent form should be attached and filled by all study participants (If dealing with primary data)
5. The risks and benefits should be included in the consent form.
6. Ensure before commencement that approval is sought from ZNHRA

Congratulations and the committee wishes you success in your work.



Prof Kasonde Bowa

MSc(Glasgow),M.Med(UNZA),FRCS(Glasgow),FACS,FCS,DPH(LSTMH),MPH(UCL)

Chairman- UNILUS REC

Professor of Urology and Consultant Urologist

Executive Dean

University of Lusaka and University Teaching Hospital School of Medicine and Health Sciences.

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Date: 15th DECEMBER, 2022

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.....
.....
**PERMISSION FOR ACKRIDE MULENGA – BSPH1410191 TO CONDUCT A
RESEARCH STUDY AT YOUR FACILITY/ INSTITUTION/ORGANIZATION**

Reference is made to the above subject matter

The University of Lusaka, School of Medicine and Health Sciences here by requests for permission for **ACKRIDE MULENGA** Public Health Student to conduct research at your facility/ institution/ organization, entitled; **AN INVESTIGATION INTO FACTORS CONTRIBUTING TO NOISE INDUCED HEARING LOSS AMONG MINERS AT CHIBULUMA MINE PLC IN KALLUSHI DISTRICT, COPPERBELT PROVINCE.** The research is in partial fulfillment of the requirements for the degree of Bachelor of Science Public Health. This is purely for academic purposes and information gained in such a way will not be used in the public domain without prior authorization from the institutions/ organizations involved.

The research topic has been cleared by the University of Lusaka, School of Medicine and Health Sciences Research Ethics Committee as per the attached copy. Data collection is expected to be done from **1st January, 2023 to 31st March, 2023.**

The University of Lusaka avails itself of this opportunity to review to your office the assurances of its highest considerations and looks forward to your timely and favorable response.



Prof Kasonde Bowa

MSc(Glasgow),M.Med(UNZA),FRCS(Glasgow),FACS,FCS,DPH(LSTMH),MPH(UCL)

Chairman- UNILUS REC

Professor of Urology and Consultant Urologist

Executive Dean University of Lusaka and University Teaching Hospital School of Medicine and Health Sciences.



NATIONAL HEALTH RESEARCH AUTHORITY

Lot No. 18961/M, off Kasama Road, Chalala, P.O. Box 30075, LUSAKA

Tell: +260211 250309 | Email: znhrasec@nhra.org.zm | www.nhra.org.zm

Ref No: NHRA0010/05/06/2023

Date: 5th June 2023

The Principal Investigator,
Mr Mulenga Ackride,
University of Lusaka,
Lusaka, Zambia.

Dear Mr Ackride,

Re: Request for Authority to Conduct Research

The National Health Research Authority Is in Receipt of Your Request for Ethical Clearance and Authority to Conduct Research Titled “**An Investigation into Factors Contributing to Noise Induced Hearing Loss Among Miners at Chibuluma Mine Plc in Kalulushi District, Copperbelt Province.**”

I wish to inform you that following submission of your request to the Authority, our review of the same and in view of the ethical clearance, this study has been **approved** on condition that:

1. The relevant Provincial and District Medical Officers where the study is being conducted are fully appraised;
2. Progress updates are provided to NHRA bi-annually from the date of commencement of the study;
3. The final study report is cleared by the NHRA before any publication or dissemination within or outside the country;
4. After clearance for publication or dissemination by the NHRA, the final study report is shared with all relevant Provincial and District Directors of Health where the study was being conducted, University leadership, and all key respondents.

Yours sincerely,

National Health Research Authority

Prof Godfrey Biemba,
Director/Chief Executive Office