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THE DETERMINANTS OF HEARING PROTECTION DEVICE USE AMONG NOISE-EXPOSED WORKERS OF CHIRANO GOLD MINES

BY

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DECLARATION

I do declare that this write up is a result of my own independent work and that references to authors’ have been duly recognized, no part of this work has been submitted to this or other institutions elsewhere for any degree.

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DEDICATION

I dedicate this work to my wife, Mrs. Afua Pokuaa Otoo and children Papa Ekow Otoo and Maame Ama Ngua Otoo.
ACKNOWLEDGEMENT

All glory and honour be to Almighty God for the unflinching love, grace, protection and sustenance in my life throughout the pursuit of this MPH degree.

My deepest appreciation goes out to my family, friends and faculty for their enormous support.

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ABSTRACT

**Background:** Several workforces in the mining industry are exposed to noise in daily doses above 85dBA, which exposes them to the risk of Occupational Noise-induced Hearing Loss (ONIHL). When noise exposure levels of workers is eliminated or lowered, employees risk of Noise-induced hearing loss will be completely reduced (Edelson *et al.*, 2009). Employees have to rely on hearing protection devices (HPD) among which include the use of ear plugs and ear muffs when it becomes evident that the noise source cannot be completely removed. The predictors of hearing protector device use that was assessed were socio-demographic, organizational level and cognitive-perceptual factors.

**Objective:** The study aimed to assess the predictors of hearing protector device use amongst noise-exposed workers of Chirano Gold Mines Ltd (CGML).

**Methodology:** Workers with noise exposure levels ≥ 85 dBA and whose work schedule was not less than 8 hours were involved. Predictors of Hearing Protector Use were assessed using questionnaires. Aside descriptive statistics, the chi-square test, multiple and ordinal logistic regressions were employed in assessing associations.

**Results:** This study established that 46% of the employees always use hearing protection device whereas 54% use the hearing protection device on a less frequent basis because they do not spend much time in a noisy area. Interpersonal influence and HPD climate were the predictors that had significant influence on the use of HPD (p-value <0.05).

**Conclusion:** Largely the Predictors’ of Workers Use of the Hearing Protection Model (PUHPM) correctly predicted a 100% usage of Hearing Protector Device among the noise-exposed workers of CGML.
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LIST OF ABBREVIATIONS

ANSI: The American National Standards Institute

CHL: Conductive Hearing Loss

dB: Decibel

DHHS: The Department of Health and Human Services

EPA: The Environmental Protection Agency

HPD: Hearing Protection Device

HSE: Health, Safety and Environment

Hz: hertz

ISO: The International Organization for Standardization

NHANES: The National Health and Nutrition Examination Survey

NIDCD: The National Institute on Deafness and Other Communication Disorders

NIHL: Noise induced hearing loss

NIOSH: The National Institute for Occupational Safety and Health

NRR: Noise Reducing Rating

ONIHL: Occupational Noise Induced Hearing Loss

PI: Private Investigator

USA: The United States of America

WHO: The World Health Organization
DEFINITION OF TERMS

Cochlea: This is the spiral organ of the labyrinth of the ear which functions as the reception and analysis of sound.

Decibel: One tenth of a bel: a unit for comparing levels of power ratios (especially sound) on a logarithmic scale.

Duration of exposure: This as used in the thesis refers to how long an individual has been exposed to noise with respect to length of service.

Hertz (HZ): The SI unit of frequency and it defines the number of cycles per second of an episodic phenomenon.

Occupational noise-induced hearing loss: Hearing loss that is the result of exposure to workplace continuous or intermittent noise of loud nature.

Work duration: Number of hours spent at the workplace
CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

The physical workload on workers has significantly lessened and there is also marked increase in productivity due to the introduction of modern-day pre-set machines in industries, factories and work places. Nonetheless a consequence of industrial mechanization is noise pollution (Bedi, 2006). Workers’ exposure to excessive noise at work is the most common avoidable cause of hearing loss (NIOSH, 2018). A study in the 1970s submitted that about 12% or more of the worldwide population is at risk of losing their hearing from excessive noise and this equates to well over 600 million persons (Alberti, Symons & Hyde, 1979). According to the European Agency on Safety and Health (EASH) at Work (2005) the most current European data collected from 1990 to 2000 indicated that more than a quarter of the European workers i.e., 29% was exposed at least, a quarter of the time at work, to high noise levels. Approximately 20% of workforce had to raise their voice to talk to other people due to exposure to high constant levels of noise about half or more of their working time. Not only can noise and its associated effect of losing once hearing affect once ability to safely work, it can also make it very difficult for a worker to audibly hear instructions or safety warnings. Noise-induced hearing loss (NIHL) is considered by NIOSH as the most common occupational illness in the US and about 30 million workforces are exposed to noise levels above normal limits. A study by Tak and Calvert (2008) indicated that the mining sector has the highest prevalence of excessive noise exposure than any sector in the world and when it comes to the prevalence of hearing loss, the mining workforce is only second to the railroad
industry. Occupational Hearing Loss (OHL) describe any type of hearing loss, that is conductive, sensorineural, or mixed hearing loss which results from unsafe nature of a work setting. According to Kim (2010) excessive noise, ototoxic chemicals, or physical trauma are some of the hazards that can result in OHL in a work environment. Noise-induced hearing loss (NIHL) is a form of Occupational Hearing Loss (OHL) that results from exposure to excessive noise.

About 10 million people in the United States of America have NHIL and above twice that number (~22 million) are exposed to excessive noise levels due to their work schedules (NIOSH, 2018). In 2007, NHIL accounted for a great percentage of occupational illness at 14% of cases (CDC, 2016). According to OSHA 2016 annual report, BLS i.e., the Bureau of Labor Statistics since 2004 reported that more than 125,000 employees had hearing loss problems resulting in about 21,000 NHIL cases costing over US$242 million on workers’ payment on hearing disabilities every year.

According to WHO, globally Occupational hearing loss affect over 275 million people and of these 80% of the affected population are in the developing countries. In developed nations on an annual basis in 2000, occupational noise accounted for 0.3 million years of workers healthy life as compared to 3.8 million years in developing nations (Nelson et al, 2005). The problem of noise-induced hearing loss in developing countries is much heavier than in developed sections of the world and it results mainly from lack of noise preventive interventions, programs and awareness of the imports of the excessive noise exposure in developing countries (Nelson et al, 2005).
Kitcher et al., (2012) reported that a high prevalence of early indices of NIHL was noted among employees in a large-scale stone crushing industry in Ghana. A study by Boateng and Amedofu (2004) also reported pockets of NIHL in local printing and corn mill employees in Ghana. According to Amedofu (2002) in a study among surface-level gold mining workers in Ghana he also reported the problem of occupational hearing loss.

A report by CDC i.e. Centers for Disease Control Prevention, 2014 indicated that to reduce noise exposure the preferred methods are engineering controls (including redesigning machineries to remove the sources of noise) and administrative controls (including alternating employees’ timetables to avoid exposures to noise). However, some of these methods may be unrealistic, expensive, or logically difficult to implement given the complexity of the work environment. Hearing protection devices for example earmuffs and earplugs are suitable when the measures for noise control are not practicable to avert loss of hearing (OSHA, 2016b).

Regular use of HPDs when a worker is exposed to extreme noise effectively help to prevent NIHL. (NIOSH, 1998).

There are several predictors to the use of Hearing Protector Devices in the work place. A study by Sbihi, Teschke, Macnab, & Davies (2017) also indicated that HPD use is associated with many factors including noise exposure, departments, jobs or occupation of the worker. Hearing Protector Devices use has been revealed to be associated with factors such as level of a worker’s exposure, employees’ perceptions of risk, safety climate of a company and social modeling (Ronis et al., 2006).
1.2 Problem statement

Workplace exposure to excessive noise is a global phenomenon which has resulted in myriads of adverse effects on health among which are tinnitus, NIHL, hypertension, difficulties in sleeping and decreased work function (Groenewold et al 2015). A report by NIOSH indicated that NIHL is included in the ten topmost work-related nuisances affecting over eleven million employees (NIOSH, 1998). The impact of hearing loss associated with work is damaging, ranging from societal isolation and stigmatization to grave nationwide financial burden (Smith, 2004). The mining sector, the construction and the manufacturing sectors had the highest degrees of prevalence of hearing impairment at 17%, 16%, 14% respectively and the public safety sector had the lowest rate of hearing impairment, at 7% (CDC, 2012).

According to recent data from NIOSH a larger population of mine workers have hearing problems, a ratio of one out of every four mine. When mine workers reach mid-60’s retirement age, the problem of hearing impairment is even worse affecting four out of five mine workers and it is mainly due to hazardous noise exposure which puts the percentage of mining workers exposed at 76% which is by far the highest prevalence of all major industries. (Chadambuka, Mususa, & Muteti, 2013).

The World Health Organization has confirmed that hearing loss from noise exposure is now the most common occupational illness worldwide, despite the fact that the condition is preventable when workers are provided with a suitable and effective form of ear protection. Historically, miners have dominated the field among those affected with NHIL, with more than half of them incapacitated by deafness before the age of 50. However, it is not just the workers, who have been affected. Over the years, the industry worldwide has been required to
pay billions in compensation to hearing-impaired workers, and this has done little to improve profits (OSHA, 2016).

Obviously, then, it is in the interest of mining companies to comply with government legislation regarding the prevention of NIHL. However, to ensure compliance, these companies must also ensure that the preventative methods adopted are sufficiently effective, among which is the use of Hearing Protector Device. In Chirano Gold Mines the use of HPDs is mandatory per the Health and Safety policy and guidelines. Even though HPD use is rolled out mine wide, data from the mine clinic suggests that workers are not using the devices as expected.

Almost every month a worker is isolated or identified with either moderate to severe or profound hearing loss at the mine clinic during audiometric assessment as part of Hearing Conservation Programme and the monthly Health report always make mention of NIHL as an impending danger due to constant reporting of workers with hearing difficulties to the clinic (Kinross Chirano Database, 2017).

NIHL among workers lead to absenteeism, low productivity and workman compensation if link with occupational exposure is established. The study sought to assess the determinants of the use of HPD in the mine.

1.3 Conceptual Framework

The Predictors’ of Workers Use of the Hearing Protection Model (PUHPM) derived from the Health Promotion Model (HPM) was used as the theoretical framework and it is founded on the findings of studies done previously on construction workforces (Lusk et al., 1997; Hong et al., 2005). As shown in Figure 1.1, predictors of health-promoting behaviors were categorized
into three: socio-demographic factors, cognitive-perceptual factors and organizational level factors. Socio-demographic factors included age, sex, educational level, working hours, years on the job and department of the worker. Cognitive-perceptual factors comprised benefits, barriers, self-efficacy, interpersonal influence and situational influence (Pender, 1996; Lusk et al, 1994; 1997). Organizational level factors included policies and regulations on safety, HPD climate and safety climate. Perceived susceptibility of actions and severity of actions were included in this study because the literature revealed that they could predict HPDs use among mining employees. Pender, Murdaugh, and Parsons’ (2010) using the revised health promotion model established that administrative, cognitive and affective factors as well as environmental factors affect the use of HPDs.

As shown in Figure 1.1, all factors included in the study were established to have direct effects on HPD use.

Additionally, the availability of HPDs as well as the frequency and intensity of noise together with duration of exposure are major factors of HPD use as well as determinants of hearing loss among workers. Workers’ knowledge on the harmful effect of occupational noise, training and re-training on hearing conservation methods influence their decision to use hearing protection device while working in noisy environment and compliance with overall safety measures of the institution. The absence or lack of knowledge and training thereof result in non-compliance and failure to use hearing protection devices, especially in the work environment where noise is above permissible exposure limits. Successful implementation of administrative control measures and controlling of personal and environmental factors will result in compliance in the use of HPD.
Socio-demographic factors
- Age
- Gender
- Educational level
- Level of experience
- Working hours
- Department

Cognitive - Perceptual Factors
- Benefits of HPD use (perceived)
- Barriers to HPD use (perceived)
- Self-efficacy in HPD use (perceived)
- Susceptibility of hearing loss
- Severity of exposure of hearing loss
- Interpersonal influences (norms, support)
- Situational influences on the use of HPD

Organizational Level factors
- Policies / Regulations
- Safety climate
- HPD climate
- Availability of HPDs
- Training and Supervision

Figure 1.1: Conceptual framework
1.4 Justification

Noise pollution is expanding swiftly mainly as a result of progression in industrialization and commercial activities. It has become a focal menace globally and WHO recognizes noise as a hazard which could affect both humans and the environment (Anomohanran, 2013). A study by Nelson et al. (2005) indicated there is little or no data regarding NIHL in most developing and under-developing countries where the mean noise level is often above suggested standards in the industrialized world. Even though HPD use is to protect workers from the impulsive impact of excessive noise, some sections of workers in industries feel reluctant in its use.

Chirano Gold Mines is one example out of the many mining companies that operate in Ghana some of whose workforce are exposed to noise levels above 85dBA daily (noise level ≤ 85dBA is referred to as an acceptable level. It is therefore important to carry out such a study to highlight the determinants of HPD use in the mining industry to come up with recommendations to promote compliance and prevent NIHL so as to reduce its prevalence among workers in the mine. The study would provide baseline data on workers’ Health Promoting Behaviour on HPDs and its effect. Information obtained from carrying out this study would again augment research data base on occupational noise pollution and HPD use among mine workers in Ghana and also strengthen existing Health and Safety policy guidelines on HPDs. Data from this research would help identify personnel, organizational and cognitive-perceptual short falls in HPD us in the mining industries and ensure that strict measures are enforced to protect miners in the country. Factors highlighted can be used as modelling for intervention of HPD use in all industries that produce hazardous noise. This study will also be a reference material for further studies by researchers and other mining
companies operating in Ghana and Africa since no much information is available on this topic in our part of the world.

1.5 General and Specific Objectives

1.5.1 General

To assess the determinants of hearing protection device use among noise-exposed workers of Chirano Gold Mines Ltd

1.5.2 Specific

1. To determine proportion of workers who use hearing protectors
2. To determine socio-demographic factors influencing hearing protector device use
3. To determine cognitive - perceptual factors that predict hearing protection device use
4. To determine the organizational level factors that predict hearing protection device use

1.5.3 Research Questions

To help realize the objectives and also put the study in focus the following research questions were asked.

1. What proportion of workers use hearing protection device in Chirano Gold Mines Ltd?
2. What socio-demographic factors influence the use of hearing protection device in Chirano Mines Ltd?
3. What are the cognitive - perceptual factors that predict the use of hearing protectors in Chirano Gold Mines Ltd?
4. What organizational level factors predict the use of hearing protectors in Chirano Gold Mines Ltd?
CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

This Chapter reviews literature and covers areas such as noise with its forms, hearing loss, its types and effects on individuals. It also looks at hearing protection device and various forms of hearing protection devices used in various mining companies or industries as well as predictors of HPD use.

2.2 Noise Exposure and its Effect

Among humans, the impact of noise on health is mostly not given much audience (Moela, 2010). Noise occurs all the time. It has a damage dose effect on worker’s health (Goines & Haglar, 2007). It is characterized by intensity (loudness), pitch (frequency) and duration of exposure which is usually appraised using a logarithmic decibel (dB) scale. Noise ranges from austere sources like a barking of a dog to multifaceted technology such as air planes and large automobiles, thus not all noise exposures are work related (Goines & Haglar, 2007). Many people are engaged in frivolous activities that produce excessive noise levels. In the US for example, about sixty millions of their population possess fire arms with inadequate hearing protection (Asamoah-Baidoo, 2011). For such a population, their susceptibility to acquiring hearing loss is high. People particularly at risk of losing their hearing due to excessive noise levels are those working at heavy production units and the agricultural sector (Fligor, 2011). The source of noise at various mining companies and industries is the machinery that they work with. Example of such machines are grinders, crashers, among others. The sources of noise exposure are from environmental and occupational noise.
Environmental noise levels are destructive open-air sounds fashioned by human activities (Goines & Haglar, 2007). These include sound radiations from transports (example road traffic and air traffic) as well as sites from industrial activities. Environmental or ambient noise pollution has many adverse implications. Its severity and enormousness will continuously escalate mainly because of present societal trends seen in developmental and population growth. Its severity “will also intensify in relation with the increase in the use of progressively more powerful, varied and highly mobile source of noise” (Schell et al., 2006).

Although environmental noise is principally considered to be an urban issue, it is not a completely modern occurrence because, it has progressed over time. Its negative effect is slowly extending to the already scarce wildlife reserves worldwide. Environmental noise pollution may not model the eminent damage that comes with atomic wars, its consequences are same and lingering (Dooley, 2002). In health, the presence of environmental noise has been computed and found to be disturbing. Quite a number of researches done further highlight the fact that, the quality of life of people is severely affected by noise. WHO developed guidelines peg permissible noise levels at 35-40dB during daytime and 30-40dB at night. For permissible indoor noise levels, WHO pegs it at 35dB whereas threshold noise levels in the bedroom is set at 30dB to allow for sound and peaceful sleep (WHO, 2010).

Occupational noise is simply noise from the work place. It is a prevalent risk factor with a clear evidence base connecting it to a significant health outcome commonly known as occupational noise-induced hearing loss (Concha-Barrientos et al., 2004). It is typically different from environmental noise since, it is by characterization connected with the work place. It requires the combined effort of the employer and employee to adequately reduce the impact workplace noise has on hearing abilities. The outcome of excessive occupational noise
level is perpetual, and its gravity increases with continuous exposure (Concha-Barrientos et al., 2004). It is therefore imperative to evaluate the load of ill health conditions related with occupational noise in order to influence policies and concentrate more research in line with reducing workplace noise levels (WHO, 2001).

2.2.1 National noise regulations

OSHA and the Control of Noise at Work – UK regulation 2005; specifies the maximum exposure level of noise any worker to be:

- Noise Exposure Level, (LAeq, 8h) of 85dBA, or

- Peak Level (Lpeak)(4) of 140 dB (Peak, unweighted) LAeq,8h of 85dBA represents “the level of daily noise exposure normalized to the average eight-hour working day. Noise level exposure must not exceed the A-weighted sound energy of 85 decibels over an eight-hour period.” Lpeak of 140 dB represents “the maximum occurrence unweighted (pure sound) peak sound pressure level. Even for a short time, any noise must not exceed 140dB since this can lead to sudden damage of once hearing. The employers are required by law, to take practical steps to minimize, isolate, or eliminate excessive amounts of noise in the work place. If the noise exceeds 85dBA after the employer completes the practical steps, the employees, and others who are exposed to the hazardous noise are then required, by law, to wear HPDs provided by the employer (OSHA, 1983).

Chirano Gold Mines operates with recourse to the international standard procedures and regulations, hence operates with noise level ≤ 85dBA.
2.3 Hearing and Hearing Loss

The ability to identify sound is known as hearing (Duthey, 2013). Sound is characterized by an extensive spectrum of frequencies. Frequencies at which humans hear sound are known as audio or sonic while frequencies below and above are called infrasonic and ultrasonic respectively. The frequency range at which humans hear is between 20 and 20000 Hz. The term hearing impairment is once inability to recognize normal range of hearing as transmitted by sound frequencies (Duthey, 2013). The ear is the medium by which humans hear. The auditory system is made up of the outer, the middle and the inner ear and an acoustic nerve known as the 8th cranial nerve. Sounds collected by the outer ear and are transmitted to the middle ear via the ear canal and tympanic membrane. Sound energy causes vibration of the tympanic membrane which allows vibrations to be transmitted to ossicles. The ossicles allow precise wave of sound transmission to the inner ear (Koop, 2015).

Hearing loss can be categorized into conductive, sensorineural and mixed hearing loss. Conductive hearing loss (CHL) occurs when hearing thresholds for bone conducted signals are enhanced much more than the air conducted signals. CHL is linked with outer and middle ear dysfunction while a normal inner ear function is maintained. A typical audiogram for CHL reveals a typical bone conduction in the range (0-25 dB) and an atypical air conduction threshold levels which are greater than 25dB. CHL invariably affects all frequency ranges, however low (250-500 Hz) and mid-range frequencies (250Hz-2 kHz) are the most affected (Alshuaib et l., 2015; American Speech-Language-Hearing Association, 2015).

Secondly, Sensorineural hearing loss (SHL) is “hearing loss caused by damage to the sensory cells of the inner ear or the vestibulocochlear nerve” (Coates, 2010). SHL is potentially the commonest form of permanent hearing loss which may present either at birth or later in life.
With this type of hearing loss, the proficiency for hearing soft sound is significantly reduced and audible sounds are perceived to be muffled (American Speech-Language Hearing Association, 2015). Factors known to cause SHL are genetics, ototoxic drug use, aging, head trauma and extensive exposure to noise that is loud. SHL caused by extensive exposure to loud noise stimulates mechanical damage to the inner ear structures. It is therefore advisable to ensure that workers with exposures above the permissible threshold limit of 85 dB are appropriately equipped with protective hearing devices. In some peculiar cases, the cause of SHL is unknown. For such instances, SHL is either described as idiopathic or sudden sensorineural hearing loss (Coates, 2010). SHL is mostly unresponsive to medical and surgical treatments. Completely avoiding the cause of SHL is the best practice. Finally, mixed loss of hearing is a blend of sensorineural and conductive damage in the same ear. In most cases, it is easy to treat the conductive damage. The sensorineural damage is often tough to treat and manage (American Speech-Language-Hearing Association, 2015).

2.4 Hearing Protection Devices

These are protective devices such as the ear muffs and ear plugs which are worn over the ears or in the ear canals to prevent dangerous or excessive noise from getting into the structures ear. These are effective to prevent and protect the worker against hearing loss when appropriate sizes are suitably fit and constantly worn. Training and retraining of workers must be done obtain long-term and effective levels of noise attenuation in their use (Murphy et al., 2004). Hearing protection device should be provided at no cost to employees working in a noise demarcated zone and must comply with the OSHA and NIOSH standards. There must be reasonable range of suitable hearing protection devices offered employees to choose by
occupational health practitioner / industrial hygienist as part of job placement and medical assessment. At quarterly intervals, the condition of HPDs should be checked and monitored by an occupational health specialist or the industrial hygienist. Monitoring according to the South African Department of Minerals and Energy (2003, p.5) “means the repetitive and continued observation, measurement, and evaluation of health and/or environmental or technical data, according to prearranged schedules, using nationally or internationally acceptable methodologies”. New and unused HPDs must be supplied to workers, in the case of earmuffs it should be correctly cleaned and, where appropriate, sterilized and stored in a suitable container. “Disposable hearing protection equipment (such as certain types of ear plugs) shall be replaced when required, taking hygiene and the general condition thereof into consideration” (SANS 10083: 2004, p. 22).

There are three different types of Hearing protectors: namely the insert-type which are earplugs that are placed in the external auditory meatus and cover the walls of the said meatus; the second type are earmuff devices and these seal against the head around the pinna, or concha; and third, labelled as seated protectors offer an acoustic seal right at the entry to the external ear canal. In selecting a HPD, the specific job situation of the user should be considered. The certification mark, sound attenuation requirements, user’s comfort, working environment and the activity for its use are some of factors needed to be taken in to account before selection.

According to American Hearing Research Foundation (2004) correctly fixed earplugs and earmuffs decrease sound intensity by 15 to 30 dBA. Both forms of hearing protection devices can be worn concurrently to reduce noise by an additional 5 dBA. Once fitted and used
correctly hearing protection device provide adequate protection no matter the type. It is required of employers by OSHA to:

✓ At no cost, make a variety of hearing devices accessible to workers exposed to an 8-hour TWA of 85 dBA or greater;

✓ Train and retrain employees in the use and care of HPDs;

✓ Ensure compliance of HPD use by workers exposed to noise level higher than 90 dBA; and

✓ Ensure double hearing protection for workers exposed to noise equal or higher than 105 dBA (OSHA, Oregon).

2.4.1 Types of HPDs

HPDs come in several different forms including; earplugs, earmuffs, communication earmuffs, and earmuff/helmet combinations. In are classed from 1 to 5 depending on their provided level of isolation from noise (NIOSH database). Class 1 HPDs are effective up to 90 dBA of equivalent noise, Class 5 HPDs are effective up to 110 dB(A) of equivalent noise. Protecting hearing from exposure to hazardous levels of noise may reduce some of the perceived negative effects that a NIHL may have on an individual. According to Ntlhakana & Kanji, (2015) all the participants interviewed owned HPDs as it was mandatory in the mines. HPDs included custom-made earplugs, corded foam earplugs, and earmuffs. Corded earplugs were the most commonly used. The majority of participants (n = 87; 96.6%) used earplugs; only three participants used earmuffs. Employers must provide a range of hearing protectors at no fee to the employees, ensure that their hearing protectors fit properly, and that they are using them correctly. Focus on comfort, convenience, and compatibility when choosing the
right hearing protectors. Employees should be able to tell when hearing protectors are uncomfortable, difficult to use, or interfere with their work after being trained in its selection. In order to be effective protective devices must totally block the entire circumference of the ear canal with an airtight seal. HPDs that are improperly fitted, dirty, or worn-out plug will not cover and can also cause irritation to the ear canal.

2.5 Hearing Protection Device use in the mining sector and other industry

Hearing protectors are used mostly to reduce noise to safe levels thereby reducing NIHL. A study of HPD use by Hansia, Mohammed, Dickinson & David (2010) found that, the regularity of reported use was lower with 24% reporting using HPDs all the time, 42% reporting everyday use but only when exposed to excessive noise, some workers reporting 20% use on some days and 10% use on most days when noise levels is high. Only 31% of respondents reported to have used HPDs always for the entire shift they were exposed, while 58% reported using HPDs sometimes and 9% workers claimed never to have used HPDs. Reported HPD use of 93% was notably higher than the observed use of 50%. Observed HPDs use was not recorded, due to complications of observation with 13% of participants.

A report from the Mine and health Safety of South Africa on a study improvement of Noise-induced Hearing Loss alertness to targeted audiences in the mining industry indicated that the reasons found in the for not wearing HPDs were discomfort (50%) of HPD use, interference of HPDs with hearing warning signals (23%), and HPDs being faulty (13%) or falling out of the ears (10%) (Hansia and Dickinson, 2010).

The study also found that in spite of training and signage 13% of respondents in the study inaccurately indicated that their workstations were not noisy. The findings of the study show
the significance of adequate noise isolation signage and enforcement. Another finding from the study was that observed use of HPDs of 50% was much lower than reported use of 93% and that among lower skilled workers the observed use was much lower.

Another report by the same authors on the Survey current NIHL awareness training and HPD practices in SA indicated that 90% of the respondents know the consequences of noise exposure, 76% know the nature of NIHL, and 89% Wear HPDs all the time 89% and 95% wore it for self-protection. According to Reddy, Welch, Ameratunga & Thorne (2014) they observed a greater reported HPD use when workers were exposed to noise, with 46% of participants reporting they always wore HPDs and 54% reporting not always wearing HPD (22% almost always, 12% usually, 4% often, 12% sometimes and 4% rarely or never).

A study on the predictors of HPD by Kim, Youngmi, Jeong, Hong & Oi-saeng (2010) indicated that the respondents reported 50.9% and 50.0% respectively as the mean and the median percent of time of using HPDs at their job site. About one-fifth representing 20.3% of participants reported not using HPDs, and about 15% always used HPDs. In the developed countries such as the US studies have shown that noise-exposed workforces used HPDs only about 14% to 49% of the time when required when exposed (Hong, 2005; Lusk et al 1998).

Review of related literature in Thailand reported that of workers exposed to noise in a canning and lumber industries only reported 28.9% to 33.1% use of Hearing Protection Device whenever they were working in noisy environment (Tantranont, 2004; Tonchumporn et al 2008).

Tantranont and Codchanat (2017) found that participants in the study reported HPD use of 77.9% when exposed to excessive noise and majority of participants representing 90.7% stated that they used earplugs (85.2%) and earmuffs (14.8%). In a study using five hundred
and forty sawmill workers from four factories by Thepaksorn, Phayong, Neitzel, Richard, Somrongthong, Ratana, & Teeranee (2018) found that majority of the participants representing about 65% reported HPD use when exposed to noise with usage rates higher among men with 70.1% use than women representing 65.2%.

A study was conducted by John, Grynevych, Welch, McBride and Thorne (2014) on the exposure to noise of workers in different economic sectors and the use of HPD among those workers. John et al., (2014) had the aim of exploring the variety of noise exposure among workers in New Zealand across all economic sectors including; Agriculture, Mining, Construction, Manufacturing, Transport/Utilities, Retail, Finance/Public administration, and Services. John et al., (2014) also examined HPD use among workers in these sectors. Data from a total of 529 participants was collected. The participants were asked, in the interview, to honestly describe how long they would use HPDs when in the noisy work environment. A total of 443 workers were sampled and interviewed on their HPD use. A total of 239 participants reported using HPDs to some degree. A total of 204 participants reported no HPD use, 13 of these participants were reported to have spent more than the recommended daily limit of exposure to noise without the use of HPD. (The accuracy of the self-reported hearing results possibly would have varied with each economic sector. This is based on the observations made by Griffin, Neitzel, Daniell, and Seixas (2009) which indicate that individuals who work in steady background noise are likely to self-report the use of HPDs with greater accuracy than individuals who work in fluctuating background noise. The outcomes of the study by John et al., (2014) suggest that over half of the workers, including tradespeople, in the New Zealand construction sector spend longer than the allowed time exposed to noise, and some of these individuals are possibly not using any form of HPD at all.
which may put them at greater risk of a NIHL and other health issues (Passchier-Vermeer, & Passchier, 2000; Stansfeld, & Matheson, 2003) it would be imperative for employers, and employees to know that these individuals are wearing HPDs to reduce their daily exposure to noise. According to Brink et al, (2002) the percentage of workers using Hearing Protection improved from 4.5% to 100% over a 17 year period when a HLPP i.e. Hearing Loss Prevention Program was introduced in a manufacturing and production company in US. A cross-sectional study looking at noise exposure compliance with OSHA standards for HLPP found that Full-shift average exposures were >85 dBA for 50% of monitored employees. Curk & Cunningham, 2006 studying self-reported use of Hearing Protection (HP) and consultation with audiologist in percussionists found after six months that 77% reported increased of HP use, 27% reported earplug acquisition, and 13% reported audiology check. A case study on noise exposure for limited cab for drilling rig found that field tests revealed 2-9 dB reductions in noise exposure (Yantek et al., 2007). Literature from other studies for example, Thailand, reported that only 29% to 41% of workers exposed to noise used HPDs continuously and these workers were from industries such marble, the pressing, food canning and lumber mills (Khrimak, 1997; Tonchumporn, 2007). The study further revealed that 24% to 56% of workers in these settings had never used HPDs (Chaloemvipaht, 1998; Khrimak, 1997). Data from 1981 to 1983 by the NIOSH in the United States found that there was an estimated prevalence of HPD use close to 41.4% also from 1999 to 2004 and results from the National Health and Nutrition Examination Survey (NHANES) showed a prevalence of 65.7%. According to Meira, Santana, & Ferrite, (2015) in spite of evidence of a positive trend in the use of hearing protection in the US, results still indicated that one out of three workers exposed to noise did not use HPD. One study reported use at 93% but informally observed
only 50% usage by mine workers. It should be noted that this observation was not part of the initial study plan, but was conducted informally as part of the validity measures. The discrepancy between the reported and actual use of HPDs could be attributed to the hot and humid conditions underground and the long working hours by participants. For example, rock drill operators might work in humid conditions, causing perspiration which could result in the HPDs becoming dislodged (Hansia and Dickinson 2010). Often, they are not reinserted. This has negative implications for the intended application of HPDs, reduces compatibility with the user’s needs and work situation and, inevitably, his/her motivation to use HPDs (Department of Minerals and Energy, South Africa, 2010). Another study found 100% ownership of HPDs (Ntlhakana & Kanji, 2015). One of the milestones set at the 2003 Mine Health and Safety Summit was to provide employees with effective HCPs in order to reduce NIHL cases in the mines. Although the use of HPDs is listed as a last option in an HCP (Department of Minerals and Energy, South Africa, 2010), most mines appear to have opted to use them as the main preventive measure, rather than other noise reduction measures such as engineering controls. Reasons include easy accessibility of HPDs, lower costs, and ease of use (Ntlhakana & Kanji, 2015).

2.6 Predictors of HPD use

There are several factors that can affect an individual’s likelihood to use HPDs. Reddy, Welch, Thorne, & Ameratuna (2012) conducted a qualitative study with the aim of investigating the factors that may influence HPD use among manufacturing companies in New Zealand. The main method used in the study (Reddy et al., 2012) was a semi-structured interview consisting of five items, open questions which reconnoitered the participants'
beliefs, behaviour, attitude, and knowledge, towards noise and HPDs, as well as investigating supports for, and barriers against HPD use. The researchers (Reddy et al., 2012) found that the perception of noise, workplace influence, valuing of hearing affected workers use of HPD. The findings of this study is also similar to the findings of previous studies which reported that interpersonal influences may predicted use of HPDs among exposed White workers and firefighters (Hong et al., 2005; Hong et al., 2013). It was indicated in this study that, the significant association of interpersonal influence on hearing protectors use reflected an exceptional work culture of the company, valued observational learning and motivation from others.

Factors such as benefits, barriers, and self-efficacy as perceived which were considered as strong predictors of HPDs use were significant in this study.

Tantranont and Codchanak (2017) conducted a recent study, where they investigated factors for and against the use of HPDs in an occupational setting using a similar theoretical framework to the HBM (Rosenstock, 1974). Tantranont and Codchanak (2017) recruited 268 participants from industrial plants in Thailand using PUHPM as the theoretical framework of the study divided potential factors that predicted HPD use into modifying and cognitive-perceptual factors. The underlying theory of the PUHPM indicates that factors that can be modified and cognitive-perceptual factors individually influence HPD use (Tantranont & Codchanak, 2017). Factors included in the theoretical framework were added by Tantranont and Codchanak (2017) because previous studies have indicated that each factor directly affected HPD use. A single-item measured questionnaire was used to collect the demographic information, including; gender, work duration, and self-reported hearing status. Participants of the study were instructed to self-report HPD use while at work using a percentage of time (0%
Results of the study (Tantranont, & Codchanak, 2017) showed that “perceived hearing status” items and “interpersonal influences” items had statistically significant correlations with HPD use. The results revealed that the PUHPM model accurately predicted 70.1% HPD use, suggesting that this model could be used to predict HPD use amongst workers who work in noisy environment. Consequently, the HBM may also be used to predict HPD use among workers who work in noisy areas, the rationale for this is that, as mentioned previously, the Cognitive-perceptual factors of the PUHPM are similar to the constructs of the HBM.

2.6.1 Socio-demographic Factors:

Positive health attributes will lead to desired health behaviour if modifying (enabling) factors are present. Modifying factors enable an individual to engage in healthy behaviour.

Demographic/Experiential factors including;

- Gender
- Age
- Working duration
- Perceived ability of hearing
- Educational level
- Level of experience

According to Raymond et al, (2006); Sbihi et al, (2010) Increased noise levels in the workplace, once age (young being), peers and supervisors influence and particularly, being
male, regardless of occupation is positively associated with HPD use. A study by Reddy, Welch, Ameratunga & Thorne (2014) indicated that the mean age of participants was 42.6 years and 96% were male. A study by Santana, Ferrite and Meira reported 59.3% and 21.4% prevalence of the use of hearing protection devices for men and women. According to Lusk, Hong, Ronis, Eakin, Kerr & Early (1999) one’s age influenced the use of HPD. Raymond, Hong, Lusk, Ronis (2006) also found that one’s level of education influenced the use of HPDs on the Predictors of hearing protection use.

A study by Ntlhakana, Kanji, Meira, et al (2015) found that the demographic characteristics of the study participants was representative of the South African mining population with regard to age, gender, race, and years of experience in mining (SA, Chamber of Mines Annual Report 2012-2013). The mean ages of the mine workers from the gold and nonferrous mine were 35.5 and 38.4 years respectively with the median age of both groups being 32 years.

It was also indicated in the study by Ntlhakana, Kanji, Meira, et al (2015) that all the participants interviewed owned HPDs as this is mandatory in the mines. HPDs included custom-made earplugs, corded foam earplugs, and earmuffs. Corded earplugs were the most commonly used. The majority of participants (n = 87; 96.6%) used earplugs; only three participants used earmuffs. The majority of participants (n = 84; 93.3%) stated that they used HPDs at all times during the 8 to 10 hours shifts. Some gold mine participants (supervisors, and health and safety officers), said that they used HPDs most of the time or half the time as they usually spent fewer than four hours per shift in noise zones.

According to McCullagh, Banerjee, Cohen and Yang (2016) their study was indicated of the 491 study participants, the average age was 45 years (SD=15 years). The average time using HPDs when in high noise at baseline was 29.5% (SD=28%), with over one-fifth (22.4%) of
subjects reporting no use of HPDs. One-fourth of the study population used HPDs 50% or more of the time. The majority of participants were male (77.2%), non-Hispanic (99%), Caucasian (98%), working as a manager (72%) on the farm and owned/worked on a small sized farm (less than 500 acres, 61%). In this same study gender difference was significant in the use of HPDs and men were more expected than women to self-report their use of HPD in this study cohort. Age of the study participants was a significant predictor for situational influences and interpersonal modeling. Older participants were more likely to report more situational influences and interpersonal modeling on HPD use.

2.6.2 Cognitive-perceptual Factors:

- Perceived benefit of HPD use
- Perceived barriers to HPD use
- Perceived self-efficacy in HPD use
- Susceptibility to hearing loss
- Severity of hearing loss
- Interpersonal influence on HPD use (Interpersonal support and modelling). This describes an individual’s views of the behaviors’, beliefs, or attitudes of others who may influence the target behavior (Nola, 2011).
- Situational influences on HPD use are the individual’s view of environmental factors as they affect health behavior (Nola, 2011).

Rosenstock (1974) constructed the HBM in an attempt to explain or predict the acceptance of health and medical care recommendations. This model proposes that an individual will consider the benefits of a particular intervention and compare whether or not they outweigh
the costs and barriers of said intervention. It is this personal valuation of the perceived benefits of an intervention compared with the conflicting barriers and costs that will determine whether or not the individual will act on the intervention or not that is, individuals conduct self-assessment of the net benefits of behaviour change and decide whether or not to act (Green & Murphy, 2014). This individual assessment of an intervention or change of behaviour is broken down into six constructs but for the purposes of this study the first five constructs were used. These six constructs that form the HBM are (i) Perceived susceptibility, (ii) perceived severity, (iii) perceived benefits, (iv)perceived barriers, (v) perceived self-efficacy, (vi) cues to action. The six constructs of the HBM are defined in Table 2.1.

**Table 2.1: Health Belief Model: Construct Definitions in hearing health related research**
(Saunders, Frederick, Silverman, & Papesh, 2013).

<table>
<thead>
<tr>
<th>Construct</th>
<th>Definition of Construct</th>
</tr>
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<tbody>
<tr>
<td>Perceived susceptibility</td>
<td>An individual’s feeling of being defenseless to a condition and the extent to which one believes he or she is a risk of acquiring the condition.</td>
</tr>
<tr>
<td>Perceived severity</td>
<td>The belief in the gravity of the penalties suffered both medically and socially if affected by the condition.</td>
</tr>
<tr>
<td>Perceived benefits</td>
<td>The belief that intervention will result in positive outcomes.</td>
</tr>
<tr>
<td>Perceived barriers</td>
<td>What a person trusts are barriers that needs to be overcome in order to successfully conduct some form of intervention.</td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Perceived self-efficacy</td>
<td>A person’s beliefs in his or her ability to use and gain benefit from the intervention.</td>
</tr>
</tbody>
</table>

This model has served as a theoretical framework for predicting the factors that impact the adoption of a selection of health-related behaviors. The following factors were identified as predictors of HPD use when the model was applied in previous studies of HPD use: perceived benefits, perceived barriers, perceived self-efficacy, and interpersonal relationships (Kim, Jeong, & Hong, 2010; Lusk & Kelemen, 1993; McCullagh, Ronis, & Lusk, 2010; McCullagh, 2011). According to Pender (2011) “Perceived competence or self-efficacy to execute a given behavior increases the likelihood of commitment to action and actual performance of the behavior.” A study by Welch, Ameratunga, Thorne (2014) indicated risk justification, HPD constraints, hazard recognition, behaviour motivation and safety culture as the five factors describing the supports and barriers with HPD use. Results of the study by Tantranont, & Codchanak (2017) revealed that “perceived hearing status” items and “interpersonal influences” items had statistically significant correlations with HPD use. The results of the studies conducted by Reddy et al. (2012), and Tantranont and Codchanak (2017) are both indicative of a potential relationship between predictors that are similar to the constructs of HBM and HPD use in occupational settings.
2.6.3 Organizational level factors

- Policies / Regulations: It is well documented that prolonged exposure to high levels of noise can lead to hearing loss and/or tinnitus (ringing sensation in the ears). This exposure can occur either at work or leisure. It should be noted that normal ageing process, certain illnesses and drugs may also be capable of causing hearing loss. The management of CGML will control the exposure of employees to harmful levels of noise at work by:

  1) Reducing noise at source wherever and whenever this is reasonably practicable.

  2) Where noise reduction at source is not reasonably practicable, by ensuring that persons are provided with suitable hearing protection that should be worn when they are likely to be exposed to noise above the second or peak action levels.

  3) Ensuring that persons use hearing protection when their noise exposure could exceed 80 dB (A) leq (8 hours).

  4) Ensuring that all staff receive appropriate instruction in the protection of hearing

- Training and Supervision - to convey to the employees’ necessary information about the hearing conservation program and the need to use the provided HPDs. The employees should understand that the use of hearing protection and audiometric testing, where exposures warrant, is a condition of employment. The training must be conducted annually and the program must include information on:

  1. The reasons for the program and how noise affects hearing;

  2. How audiometric tests are conducted and what they show;
3. The purpose, advantages, disadvantages, and attenuation of the hearing protection devices offered for their use;
4. The fitting and use of hearing protection devices; and
5. The care and maintenance of hearing protection devices.

- Safety climate: This term is used to refer to the quantifiable aspects of safety culture in an organization. It gives a ‘snapshot’ of the culture of the organization at a given moment in time (Flin, Burns, Mearns, Yule & Robertson 2006; Hann, Bower, Campbell, Marshall & Reeves 2007).

- HPD climate: Organizational support for the use of HPDs.

- Severity of exposure

The values, policies and action of companies in respect of noise and hearing protection are the factors at the ‘organizational level’. This presents a multilevel viewpoint and provides the basis for developing interventional programs that promote HPD use.

Zohar (1980) highlighted how the safety climate in an organization helps shape the organization’s safety culture and compliance to hearing protector device use. Assessment of the organizations safety climate helps to understand how workers react to safety issues and identify, interpret and evaluate the values of the organization. Safety climate and culture of the organization may be influenced by leadership style on how to approach and deal with issues of safety and most roles are played by supervisors and managers (Zohar and Luria, 2010).

In their study, Arezes and Miguel (2008) noted employees reported wearing protective hearing gear when they viewed the safety climate more positively regarding perception of the work environment, personal motivation as received from work, and workload. Vinodkumar
and Bhasi (2010) found that when management is committed to safety rules and procedures it predicts safety compliance directly whereas safety training to the workers and safety communication and positive feedback predicted safety compliance indirectly.

Previous researchers investigated the barriers to preventive health actions for occupational NIHL (Patel et al., 2001). Thirty-two individuals from two mines located in the US, who had a substantial risk of obtaining a permanent NIHL, volunteered to participate in the study. It was reported that “fewer than 10% of the participants mentioned that they regularly wore hearing protection” (Patel et al., 2001, p.159), suggesting that these participants were at greater risk to NIHL because of the lack of HPD use. The researchers (Patel et al., 2001) formed focus groups with protocol based from the Extended Parallel Process Model and the HBM theoretical frameworks. The questions in the focus group protocol were separated into four sections which assessed the knowledge and individual perceptions surrounding the susceptibility and severity of NIHL, determined the levels of self-efficacy, assessed whether barriers discouraged HPD use and what types of barriers were responsible for this, and finally, identifying participants’ ideas and suggestions for the development of effective hearing conservation campaigns. The study conducted by Patel et al. (2001) focused on the third section, which investigated barriers which may inhibit HPD use. Qualitative data was collected from four focus groups using the protocol mentioned previously. Results from the study revealed barriers which discouraged the use of HPDs among participants, these barriers were separated into two groups; Environmental factors, which were defined as “external realities that act as systemic constraints against behavioural change: they occur outside of the miner’s body or mind” (Patel et al., 2001, p.162), and individual factors, which were defined as “internally perceived cues that prevent engagement of healthy actions: they are perceptions,
subjective realities” (Patel et al., 2001, p.163). Results from the study revealed barriers which discouraged the use of HPDs among participants, these barriers were separated into two groups:

Environmental factors that inhibited participants’ use of HPDs in an occupational setting included:

- Economy – Economic concerns were reported by participants. Fear of possibly of being demoted or fired from not being able to communicate properly while wearing HPDs. Potential infections that may occur from wearing insert HPDs, such as ear plugs, may have resulted in medical visits that the participants could not afford. This links with the second environmental factor.

- Medical – Medical concerns were reported by participants. Participants reported that the use of earplugs has resulted in ear infections for them in the past, and as a result they had stopped using HPDs in an attempt alleviate that issue.

- Technology: Participants reported they found some HPDs too bulky, uncomfortable, or heavy to wear consistently during their 10 hour working day.

- Organizational structure of the group: The participants reported that over several years they have developed systems within their work groups in order to work efficiently, and any change to the systems they had set up could possibly cause a disruption to work efficiency and work quality. It was reported that participants viewed the use of HPDs as a change that would be detrimental to the work systems already in place.
Individual barriers that inhibited participants’ use of HPDs in an occupational setting included:

- **Perceived hearing ability**: Participants reported that HPD use made it more challenging to effectively communicate with the members of their work groups.

- **Emotional experience**: Participants reported that they experienced feelings of fear, isolation, and frustration when using HPDs. Participants suggested that HPDs would significantly limit their hearing, causing them to experience feelings of isolation from their colleagues.

- **Perceived subjective norms** – perceptions of no habitual use as the accepted norm. Participants suggested that the lack of HPD use as a social norm may have prevented many workers from using HPDs.

The authors of the literature reviewed in this section (Patel et al., 2001; Reddy et al., 2012; Tantranont, & Codchanak, 2017) have made indications to several factors which may influence the use of HPDs. Although these studies were conducted using differing theoretical frameworks, they each indicate factors which may influence the use of HPDs. Factors that influence HPD use may be external, or modifying factors (Patel et al, 2001; Tantranont, & Codchanak, 2017) which happen outside of the individual, and which the individual has no control over. Internal factors may also influence HPD use, these factors occur within the body and mind of the individual (Patel et al, 2001).

According to Mccullagh, Lusk, & Ronis, (2002), interpersonal influences of HPD use, barriers to HPD use and situational influences correctly predicts ones use of HPD in 78% of all cases. This was determined whiles using the modified Health Promotion Model to assess farmers’ use of HPD. Few studies on factors influencing use of HPD use among factory and
construction workers have been reported. In their study Melamed, Rabinowitz, Feiner, Weisberg, and Ribak (1996) found that lower perceived severity, perceived risk of hearing loss, lower perceived effectiveness, and barriers affected HPD use among manufacturing workers in Israel. In a study of 645 factory workers in the United States, Lusk et al. (1994) used structural equation modeling to find that value of use, self-efficacy, situational factors, perceived barriers to hearing protector use, gender, and age were predictors of HPD use. Another study by Lusk, Ronis, & Hogan, (1997) among 359 construction workers found that value of use, self-efficacy, perceived health, perceived barriers to hearing protector use, age, and gender were predictors of HPD use in this worker group. According to Edelson et al., (2009), workers’ attitudes and beliefs toward HPDs use have been found to be important predictors of HPD use. According to Srisuphan, Kaewthummanukul, Suthakorn, Jormsri, & Salazar, (2009) determinants of HPD use include interpersonal, intrapersonal and organizational factors – all of which has a bearing on its use. Another study by Sbihi, Teschke, Macnab, & Davies,(2017) also indicated that HPD use is associated with many factors including noise exposure, departments, jobs or occupation of the worker. According to Mccullagh et al., (2002) three cognitive-perceptual factors based on the HPM model were significantly related to protective behavior for HPD among farmers and these factors are interpersonal influences, barriers and situational influences all these predicted HPD use in 78% of the cases. In the US it was reported that about 17% of farmers, 72% of Mexican-American workers, 76% of manufacturing workers and 78% of all Hispanic workers worn HPDs when exposed to noise (McCullagh, Lusk, & Ronis, 2002; Lusk, et al., 2003; Raymond, Hong, Lusk, & Ronis, 2006)
2.7 Conclusion

The use of heavy machinery coupled with other working environment contributes to excessive noise produced at the mining industry. This makes workers susceptible to NIHL. Other dynamics include; gaps in knowledge of noise dose/source relationships, the unavailability of effective noise controls and the need for worker education (Rabinowitz, 2000). Rarely are workers involved in control regimes aimed at reducing exposures at the work place. This is especially predominant in most developing countries where the import of NIHL has not been fully understood. Worker’s involvement in such matters is critical in the implementation of exposure reduction strategies.

Industries in the advanced countries have made modifications which primarily include the introduction of an occupational hearing conservation program. This program is made up of administrative and engineering controls aimed at reducing noise exposure, training or education of employees in the use of protective hearing device and regular audiometric testing for workers exposed to noise above the permissible exposure levels. Obsolete and noisy machinery have been substituted and acoustic engineering controls have been employed to further eliminate harmful noise. All efforts are therefore geared towards protecting workers from acquiring NIHL. The use of personal protective devices on the hierarchy of controls is often the last option to be considered. However, in developing and under-developed countries, personal protective device is firstly employed to protect workers from excessive noise exposures. This is because elimination, substitution and engineering controls are extremely expensive to practice. It has been found that, workers do not comply with the use of personal protective device because of lack or little sensitization on the effect of NIHL. Employers should therefore be concerned about the health and safety of their employees. Future research
should focus on obtaining statistics of workers affected by occupational noise levels. Again evaluating the disease burden of NIHL and cost will ensure that, stringent measures are put in place to protect the hearing of workers. Not much studies has been done on determinants of HPD use in the mining industry. Several of the worker studies are inhibited by the lack of reporting of validity and reliability of instruments used (Rabinowitz et al., 1996; Melamed et al., 1996; Wadud et al., 1998). There is a therefore the need to conduct model-based studies using reliable and valid instruments to identify the important variables predicting mining workers’ HPD use.
CHAPTER THREE

3.0 METHODS

3.1 Study Area

Chirano Gold Mines Limited is located in Sefwi Wiawso, Bibiani, in the South-Western part of the Republic of Ghana. It is approximately 100 kilometers southwest of Kumasi. The mine is located in the Bibiani gold belts. Chirano Gold Mines Limited has a mining plan with gold deposits in both surface operations and underground operations extending along a strike length of more than 10 kilometers on latitude 6° 36’ N and longitude 2° 17’ W. Chirano Gold Mines Limited achieved its first gold pour in October 2005, and comprises 11 deposits along the Chirano gold belts.

Chirano Gold Mines Limited has about 1,046 workforce which includes managers, senior and junior staffs, graduate trainees, national service personnel and short-term contract employees. The workforce work in 9 main different departments – Underground, Open Cut (Surface Operations), Engineering, Processing, Technical Service, Finance, Human Resource, Continuous Improvement and Safety, Health and Environment. The proposed study concentrated on employees in the Underground, Open Cut (Surface Operations), Engineering, Processing and Technical service departments since they are involved in production of gold hence their working activities mostly generate hazardous noise and thus expose them to the effects of hazardous noise. Other employees from the other departments not mentioned but had employees stationed in the production sites were also included. Due to excessive noise production from the work environment, health facility visits due to hearing problems has seen a marginal increase over the years and no study has been conducted to investigate the problem.
3.2 Variables

3.2.1 Dependent variable

The main dependent variable was hearing protection device use defined as always or sometimes use of hearing protectors, such as ear plugs and muffs.

3.2.2 Independent variable

The independent variables are socio-demographic, cognitive-perceptual and organizational level factors.

Socio-demographic factors included age, gender, level of education, years’ experience in mining and department that employees work.

Cognitive – perceptual factors included:

Perceived Benefits of HPD use measured models such as “preventing hearing loss” and “preventing noise annoyance.” An examples of the items is the following: “Preventing hearing loss is very important to me” and “Wearing hearing protection protects me against hearing loss from noise.”

Perceived Barriers to HPD use had two dimensions: individual’s personal discomfort and communication interference. Examples of items measuring this construct are: “Wearing hearing protection makes it very hard to talk to people,” “Hearing protectors are too uncomfortable for me to wear.”

Perceived self-efficacy in HPD use assessed views of workers’ abilities to use Hearing protection device properly and cope with the barrier to HPD use. “You can tell when you need to wear my hearing protection” and “You know how to wear your hearing protection correctly.”
Perceived susceptibility to hearing loss items such as: “My hearing will not be affected by noise, even if I don’t wear hearing protection” and “I believe exposure to loud noise can hurt my hearing.”

Perceived severity of exposure measured ones perception of losing his hearing. An example is: “It would be harder for me to understand what people say if I lost some of my hearing.”

Interpersonal influence measured constructs such as social network and social support systems in the workplace from coworkers may affect HPD use. An example is, “Other workers at this site wear hearing protection when it’s noisy”

Situational influences measured the policies, regulations and functions of the organization that promote workers’ use of hearing protector device. Example of such items is: “It is easy for me to get hearing protectors at this site.”

Organizational level factors included safety climate and HPD climate as well as training, supervision, safety policies and availability of HPDs. HPD and Safety climate measured the organizational leadership function played by supervisors in ensuring workers use of HPDs and compliance with safety rules. Examples of HPD and Safety items included: “My supervisor sets a good example for me when it comes to hearing protection” and “My supervisor talks with me about how to improve safety.”

These definitions have been applied in previous studies (Lusk, 2002; Lusk, Kerr, Ronis, & Eakin, 1999; Lusk et al., 2003; McCullagh, 2011; Tantranont, & Codchanak, 2017).

3.3 Source Population / Study Population

The source population are individuals working in the production departments. Of this, 389 workers were randomly selected form Processing, Engineering, Technical Service, Surface Operations (Open Pit), and Underground operations for the study.
3.4 Inclusion and Exclusion Criteria

Employees included in this study work in environment where the noise exposure level is ≥85 dBA and who are also workers in the production departments - Underground, Surface Operations, Technical Service, Engineering and Processing and all employees who consented to follow the study to conclusion. All contractors were also excluded from the study.

3.5 Sampling

3.5.1 Sample size determination

The sample size of 389 was derived from the Cochran formula (1963) below. The proportion of Hearing Protector Device (HPD) use was 41% which was obtained from a study in predicting HPD use among Construction Workers in the US (Edelson et al, 2009). To the best of my knowledge, no similar study has been done in any developing country and so I decided to use the prevalence of HPD use among US population. This is consistent with my company’s policy in that the company is a multi-national and applies the Health and Safety principles that is consistent with Kinross Gold Corporation in Canada.

The Cochran formula (1963):

\[ n_0 = \frac{Z^2pq}{e^2} \]

Where:

n0 = estimated sample size

Z = confidence level (95% level of confidence - 1.96)

p = the estimated proportion of HPD use = 0.41

q = 1 - p = which is the proportion of workers not using HPD = 1 - 0.41 = 0.59
d = 0.05 as the acceptable margin of error.

Therefore

\[ n_0 = (1.96)^2 (0.41) (0.59) / (0.05)^2 \]

Therefore, \( n = 1.96^2 \times 0.41 \times (1-0.41)/0.05^2 = 371.7 \approx 372 \) workers respectively.

5% (19) margin of error was included to cater for incomplete questionnaire and non-response.

Therefore, \( n = 391 \).

### 3.5.2 Sampling Method

Simple Random Sampling was used in this study. A list of all workers in each department was made available to the research team. Numbers were allocated to all workers on the list. Using a random number generator, the workers were proportionately selected for the study separately for each department.

**Table 3.1: Proportionate distribution of workers in each department**

<table>
<thead>
<tr>
<th>Departments</th>
<th>No. of workers in each department</th>
<th>Number of sampled miners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Operation</td>
<td>168</td>
<td>81</td>
</tr>
<tr>
<td>Underground Operation</td>
<td>146</td>
<td>70</td>
</tr>
<tr>
<td>Technical service</td>
<td>108</td>
<td>52</td>
</tr>
<tr>
<td>Processing</td>
<td>104</td>
<td>50</td>
</tr>
<tr>
<td>Engineering</td>
<td>248</td>
<td>119</td>
</tr>
<tr>
<td>Others (HSE, Exploration)</td>
<td>37</td>
<td>17</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>809</strong></td>
<td><strong>391</strong></td>
</tr>
</tbody>
</table>
3.6 Data Collection Procedure

3.6.1 Data Collection Tool

Data was collected on the variables of interest using a well-structured self-administered questionnaire on Predictors’ of Workers Use of the Hearing Protection Model (PUHPM) (see Appendix 1) adapted from Pender’s Health Promotional Model. The questionnaire has eleven sections: the first section respondents’ socio-demographic characteristics. The health promotion behavior which measured the dependent variable had 4 items, with a sample question such as “Do you use HPD when working?” The independent variables of interest cognitive – perceptual factors and organizational level factors (Safety climate and HPD climate) and two factors (interpersonal influences and situational influences) which found to predict HPD use were measured using composite scales under nine domains of predictors of HPD use: self-efficacy (3 items; 5-point Likert scale), susceptibility (2 items; 5-point Likert scale), severity of exposure (2 items; 5-point Likert scale), benefits (3 items; 5-point Likert scale), barriers (4 items; 5-point Likert scale), interpersonal influences (4 items; 5-point Likert scale), situational influences (3 items; 5-point Likert scale), HPD climate (2 items; 5-point Likert scale), safety climate (6 items; 5-point Likert scale).

3.6.2 Data collection procedure

Meetings were held with management and safety representatives of the departments chosen for the study. The purpose of the study and modalities for data collection were explained during the meeting. Four safety reps were recruited and trained on the study objectives, data collection procedures and timelines, confidentiality and privacy and general expectation of the study.
The participants were randomly selected from all the nine departments of the mine (Production and non-production) based on their unique IDs. Calls were made to selected participants to obtain informed consent of the worker, workers who were not available for the study in the stipulated time were replaced by the next available sample.

A meeting was held with all workers explaining the purpose of the research to them. Questions in the questionnaire were explained to them to ensure clarity of all questions. They were assured of confidentiality of any data collected from them.

Questionnaires of the study were shared to workers directly by the researcher and four other safety officer, or safety representatives from the various departments during toolbox meetings and safety time outs.

The questionnaire was designed in English, but the questions were either asked in English or local dialects which are Twi and Sefwi for better understanding of respondents who had challenges with the English language. Participants had a maximum period of 10 to 15 minutes to fill out the questionnaire. Data collection was carried out for 6 weeks concurrently with data entry and cleaning.

3.7 Quality control

Four research assistants who were mainly safety officers and safety representatives were trained for two days to make sure they understood the objectives and methodology of the study to ensure the process of data collection was uniform and data obtained was uniform and of high quality. Emphasis was placed on techniques of data collection, rapport creation, assurance of privacy and confidentiality, the meaning of the items and correct ticking of responses will be provided. They were very fluent in the local English and Twi. The research assistants and the data entry clerk were monitored closely to avoid mistakes. All proceedings
for data collection were thoroughly described to the participants by trained assistants. Instructions given were clear, simple and precise. Questionnaires were mainly filled after close of work or during safety tool box meetings and usually lasted between 10-15 minutes. The questionnaires were numbered before data entry to avoid entering one questionnaire two times. Data was however entered twice by two data entry persons and crosschecked to make sure data was correctly entered.

3.8 Data processing and analysis

3.8.1 Data processing

Respondents’ data from completed questionnaires were entered manually into an excel sheet (Excel version 2016). A coding frame containing the scores corresponding to the responses on the questionnaires served as a guide for data entry to aid ‘translate’ the survey data into a workable dataset. Respondents IDs were clearly labelled so as to appropriately tally information gathered to data entered on the computer. After data entry was completed, data cleaning was done by running all frequencies, identifying missing records and filling in missing detail. The data was cross checked for errors. The data was exported to STATA Version 15 for further analysis.

3.8.2 Statistical analysis

Frequency and percentages were used to describe the characteristics of the study participants. The Pearson Chi-square and Fisher’s exact test of association was used to test for association between the determinants of interests and HPD use. All 5 point Likert scales items with respect to cognitive-perceptual and organizational level factors (Strongly disagree, disagree, undecided, agree and strongly agree) were collapsed into two categories with strongly
disagree, disagree and being grouped as ‘disagree’ whilst agree and strongly agree grouped as ‘Agreed’. However less than five responses were undecided and so were added to disagree.

A composite mean score was obtain for each of the cognitive-perceptual and organizational level factors on a scale of one (1) to five (5), with one (1) being higher disagreement and five (5) being higher agreement after all negative items were reversed for each respondents. The minimum, maximum, mean and standard deviation scored by the respondents was used to describe the composite mean scores.

The simple (unadjusted) logistic regression model (Crude Odds ratio) was used for all socio-demographic characteristics of study participants as well as the composite mean scores from the cognitive-perceptual and organizational level factors on use of HPD. All socio-demographic characteristics of study participants though not significant, were included in the multiple (adjusted) binary logistic regression model (Adjusted Odds ratio) because revealed literature indicated they were significant in predicting HPD use among miners hence they were added to the logistic regression to see their overall effects, whilst the other cognitive-perceptual and organizational level factors that had a significant level less or equal to 0.2 (though not very significant, these variables were added to realize the overall effect on the analysis) from the unadjusted model were also included in the adjusted model. All statistical significance were determine at a 0.05 level whilst a 95% Confidence Interval (CI) were determined for all point estimates. All socio-demographic characteristics of study participants were added to the logistic regression

3.9 Ethical consideration

Ethical clearance to conduct the study was obtained from the Ghana Health Service Ethical Review Committee through School of Public Health. Permission was obtained from the
General Manager and Vice President of Kinross Chirano Gold Mines Limited. Permission was obtained from all managers whose departments were selected for involvement in the study.

The participants were encouraged and permitted to ask any questions about the study and the investigator and research assistants provided satisfying answers to them. The study poses minimal or no risk to the participants. The only discomfort associated with this study is time needed to fill out the questionnaire. No participants was judged by the answers he / she provided by anyone related to the study neither was the answers given had a negative effect on their current and future management.

There was no direct benefit obtained from the questionnaire, however the information provided by participants aided in the formulation of strategies for effective occupational surveillance. Participation was entirely voluntary and participants were not under any obligation to do so, and were at liberty to withdraw from the study at any point in time. Once willingness to participate was confirmed by either signing or thumb printing in the space provided on the consent form. All the information obtained from this study was kept confidential and used for the purpose indicated for the study. The information was securely stored without the names of the respondents in a file which was accessible only to the research team. Each participant was assigned an ID code and was kept confidential accessible to only the researcher and supervisor. Also data entered into a computer was password protected and known by only the principal investigator. The results of the study was disseminated in such a way that no information was linked to the identity of any particular participant. The research was solely funded by the principal investigator. The study participants were given soft drinks and water as refreshment.
CHAPTER FOUR

4.0 RESULTS

4.1 Demographic characteristics of study participants

A total of 389 workers participated in the study, all of whom were males. The mean age of the study participants was 11.1 (±2.7) years with 16.5% of them between the age 26 and 25 years inclusive, 45.8% of them were in the age range 36 to 45 years. A few of them (6.2%) of them had JHS education as their highest, 25.7% with SHS education and 22.9% with degree or masters level of education. The mean number of years of mining was 11.9(±0.8) with about three quarters of the study participants had 10-15 years of mining experience, 21.6% with less than 10 years and 5.7% with 16 to 20 years of mining experience. Majority of the workers were in the engineering departments. More descriptive on the demographic characteristics of study participants can be read from Table 4.1.

Table 4.1: Demographic characteristics of study participants (N=389).

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age group</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26-35 years</td>
<td>64</td>
<td>16.45</td>
</tr>
<tr>
<td>36-45 years</td>
<td>178</td>
<td>45.76</td>
</tr>
<tr>
<td>46-55 years</td>
<td>118</td>
<td>30.33</td>
</tr>
<tr>
<td>56-61 years</td>
<td>29</td>
<td>7.46</td>
</tr>
<tr>
<td><strong>Highest level of education</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JHS</td>
<td>24</td>
<td>6.17</td>
</tr>
<tr>
<td>SHS</td>
<td>100</td>
<td>25.71</td>
</tr>
<tr>
<td>Diploma</td>
<td>61</td>
<td>15.68</td>
</tr>
<tr>
<td>Technical</td>
<td>115</td>
<td>29.56</td>
</tr>
<tr>
<td>Degree/masters</td>
<td>89</td>
<td>22.88</td>
</tr>
<tr>
<td><strong>Number of years of mining</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;10 years</td>
<td>84</td>
<td>21.59</td>
</tr>
<tr>
<td>10-15 years</td>
<td>283</td>
<td>72.75</td>
</tr>
<tr>
<td>16-20 years</td>
<td>22</td>
<td>5.66</td>
</tr>
<tr>
<td><strong>Department</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Surface operation 81 20.82
Underground 70 17.99
Technical service 52 13.37
Processing 50 12.85
Engineering 119 30.59
Others* 17 4.37

*Workers who are not from the production departments but have offices located in the production departments.

4.2 Use of hearing protection device (HPD).

All the workers recruited into the study use hearing protectors, however 46% of the 389 participants reported to use hearing protection device always while the remaining 54% reported to use HPD sometimes. A 95% confidence interval estimates of the proportion of workers who always use HPD from the study is between 40.47% and 50.60%.

A high majority (96%) of the study participants preferred to use ear plugs as opposed to the few (4%) that preferred ear muff. Figure 4.3 showed that of the workers who do not always wear their HPD, because they do not spend much time in noisy area while few of them do not do so because it is either uncomfortable or they never think about it.

Figure 4.1: Use of hearing protection device (HPD).
4.3 Association between socio-demographic characteristics and use of HPD

In assessing the factors associated with the use of HPD, the Pearson’s chi-squared test was used. From Table 4.2, none of the demographic characteristics showed significance association with the use of HPD, however the type of HPD use was a significant factor associated with the use of HPD. Of the study participants who always use HPD, 94.3% of them uses ear plug while 98.1% of those who sometimes uses HPD uses ear plug.
Table 4.2: Chi-square test of association between socio-demographic characteristics and use of HPD (n=389)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>USE OF HPD</th>
<th></th>
<th>chi-square</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sometimes (%)</td>
<td>Always (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Age group</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26-35 years</td>
<td>31 (14.62)</td>
<td>33 (18.64)</td>
<td>1.34</td>
<td>0.72</td>
</tr>
<tr>
<td>36-45 years</td>
<td>100 (47.17)</td>
<td>78 (44.07)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>46-55 years</td>
<td>66 (31.13)</td>
<td>52 (29.38)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>56-61 years</td>
<td>15 (7.08)</td>
<td>14 (7.91)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Highest level of education</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JHS</td>
<td>12 (5.66)</td>
<td>12 (6.78)</td>
<td>6.52</td>
<td>0.163</td>
</tr>
<tr>
<td>SHS</td>
<td>64 (30.19)</td>
<td>36 (20.34)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diploma</td>
<td>34 (16.04)</td>
<td>27 (15.25)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical</td>
<td>61 (28.77)</td>
<td>54 (30.51)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degree/masters</td>
<td>41 (19.34)</td>
<td>48 (27.12)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Number of years of mining</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;10 years</td>
<td>42 (19.81)</td>
<td>42 (23.73)</td>
<td>0.47</td>
<td>0.791</td>
</tr>
<tr>
<td>10-15 years</td>
<td>162 (76.42)</td>
<td>121 (68.36)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16-20 years</td>
<td>8 (3.77)</td>
<td>14 (7.91)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Department</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface operation</td>
<td>51 (24.06)</td>
<td>30 (16.95)</td>
<td>8.66</td>
<td>0.123</td>
</tr>
<tr>
<td>Underground</td>
<td>40 (18.87)</td>
<td>30 (16.95)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical service</td>
<td>21 (9.91)</td>
<td>31 (17.51)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Processing</td>
<td>30 (14.15)</td>
<td>20 (11.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engineering</td>
<td>63 (29.72)</td>
<td>56 (31.64)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>7 (3.3)</td>
<td>10 (5.65)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Type of HPD use</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ear plug</td>
<td>208 (98.11)</td>
<td>167 (94.35)</td>
<td>3.94</td>
<td>0.047*</td>
</tr>
<tr>
<td>Ear muff</td>
<td>4 (1.89)</td>
<td>10 (5.65)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

%: Column percentage. *: p-value <0.05.

4.4 Association of Cognitive-Perceptual Factors (Self efficacy, Susceptibility, severity of exposure and benefits) on the use of HPD

From the Pearson’s chi-square test of association, the important of prevention of hearing loss to the worker and the ease of wearing HPD and hearing machinery or being talked to were the factors that were significantly associated with the use of HPD. Of the workers who always use HPD, 92.1% agreed that preventing hearing loss was very important to them while the rest of the 7.9% disagreed. Also of the workers who always use HPD, 62.2% agreed that wearing HPD can make it easier for them to hear machinery or talked to, while 37.8% of disagreed. (Table 4.3).
Table 4.3: Chi-square test of association on Cognitive-Perceptual Factors (Self efficacy, Susceptibility, severity of exposure and benefits) on the use of HPD (n=389)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>USE OF HPD</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sometimes</td>
<td>Always</td>
<td>chi-square</td>
<td>P-value</td>
<td></td>
</tr>
<tr>
<td><strong>SELF EFFICACY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can tell when to wear HPD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>15 (7.08)</td>
<td>10 (5.65)</td>
<td>0.33</td>
<td>0.568</td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>197 (92.92)</td>
<td>167 (94.35)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Know how to correctly wear HPD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>4 (1.89)</td>
<td>5 (2.82)</td>
<td>0.38</td>
<td>0.540</td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>208 (98.11)</td>
<td>172 (97.18)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can ask for help on how to wear HPD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>4 (1.89)</td>
<td>5 (2.82)</td>
<td>0.38</td>
<td>0.540</td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>208 (98.11)</td>
<td>172 (97.18)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SUSCEPTIBILITY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If I don’t wear HPD my hearing will not be affected</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>199 (93.87)</td>
<td>164 (92.66)</td>
<td>0.23</td>
<td>0.633</td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>13 (6.13)</td>
<td>13 (7.34)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>My hearing can be hurt by exposure to noise</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>18 (8.49)</td>
<td>10 (5.65)</td>
<td>1.17</td>
<td>0.28</td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>194 (91.51)</td>
<td>167 (94.35)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SEVERITY OF EXPOSURE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If I lost my hearing, it would be harder to understand what people say</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>17 (8.02)</td>
<td>19 (10.73)</td>
<td>0.85</td>
<td>0.357</td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>195 (91.98)</td>
<td>158 (89.27)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Losing my hearing wouldn’t be a big problem for me</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>161 (75.94)</td>
<td>136 (76.84)</td>
<td>0.04</td>
<td>0.837</td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>51 (24.06)</td>
<td>41 (23.16)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>BENEFITS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hearing loss prevention is important to me</td>
<td></td>
<td></td>
<td></td>
<td>7.93</td>
<td>0.005**</td>
</tr>
<tr>
<td>Disagree</td>
<td>4 (1.89)</td>
<td>14 (7.91)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>208 (98.11)</td>
<td>163 (92.09)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wearing HPD protects me against hearing loss from noise</td>
<td></td>
<td></td>
<td></td>
<td>2.83</td>
<td>0.093</td>
</tr>
<tr>
<td>Disagree</td>
<td>12 (5.66)</td>
<td>4 (2.26)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>200 (94.34)</td>
<td>173 (97.74)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can be able to talk or hear machinery when I use HPDs</td>
<td></td>
<td></td>
<td></td>
<td>9.26</td>
<td>0.002**</td>
</tr>
<tr>
<td>Disagree</td>
<td>113 (53.3)</td>
<td>67 (37.85)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>99 (46.7)</td>
<td>110 (62.15)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

%: Column percentage. *: p-value <0.05. **: p-value <0.01.

Note: <5 people reported undecided so were added to disagree.
4.5 Association of Cognitive-Perceptual Factors (Barriers, Interpersonal influences and situational influences) with use of HPD

From the Pearson’s chi-square test of association, unsafeness of HPD due to block out of danger signals, other workers reminding respondents the need to wear HPD and workers thinking their supervisors needed them wear HPD were the factors that showed significant association with the use of HPD among workers.

Among those who always wear HPD, 61.0% of them agreed that other workers remind them when they need to wear HPD while 39.0% of them disagreed. Also among those who always wear HPD, majority (81.4%) agreed that their supervisors thinks they need to wear HPD, while 18.6% of them disagreed. More on the barriers, interpersonal and situation influential factors associated with the use of HPD can read from Table 4.4.

Table 4.4: Chi-square test of association of Cognitive-Perceptual Factors (Barriers, Interpersonal influences and situational influences) with use of HPD (n=389)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>USE OF HPD</th>
<th>chi-square</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sometimes</td>
<td>Always</td>
<td></td>
</tr>
<tr>
<td><strong>BARRIERS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It is hard to talk to people when I use HPD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>147 (69.34)</td>
<td>135 (76.27)</td>
<td>2.32</td>
</tr>
<tr>
<td>Agree</td>
<td>65 (30.66)</td>
<td>42 (23.73)</td>
<td></td>
</tr>
<tr>
<td>HPD use is time consuming</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>187 (88.21)</td>
<td>163 (92.09)</td>
<td>1.61</td>
</tr>
<tr>
<td>Agree</td>
<td>25 (11.79)</td>
<td>14 (7.91)</td>
<td></td>
</tr>
<tr>
<td>It is unsafe to use HPD because it blocks out danger signals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>194 (91.51)</td>
<td>149 (84.18)</td>
<td>4.97</td>
</tr>
<tr>
<td>Agree</td>
<td>18 (8.49)</td>
<td>28 (15.82)</td>
<td></td>
</tr>
<tr>
<td>HPD us is uncomfortable to me</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>148 (69.81)</td>
<td>138 (77.97)</td>
<td>3.30</td>
</tr>
<tr>
<td>Agree</td>
<td>64 (30.19)</td>
<td>39 (22.03)</td>
<td></td>
</tr>
<tr>
<td><strong>INTERPERSONAL INFLUENCES</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>My colleagues workers wear HPD when its noisy</td>
<td></td>
<td></td>
<td>1.53</td>
</tr>
<tr>
<td>Disagree</td>
<td>16 (7.55)</td>
<td>8 (4.52)</td>
<td></td>
</tr>
</tbody>
</table>
Agree  196 (92.45)   169 (95.48)  
Disagree  38 (17.92)   69 (38.98)  
Agree  174 (82.08)   108 (61.02)  

Other workers make fun of me when I wear HPD  
Disagree  190 (89.62)   156 (88.14)  
Agree  22 (10.38)   21 (11.86)  

SITUATIONAL INFLUENCES  
Easy for me to get HPD at this site  
Disagree  23 (10.85)   30 (16.95)  
Agree  189 (89.15)   147 (83.05)  

I can choose from several types of HPDs at this site  
Disagree  97 (45.75)   88 (49.72)  
Agree  115 (54.25)   89 (50.28)  

My supervisor encourages me to wear HPD, even if exposure is short  
Disagree  22 (10.38)   33 (18.64)  
Agree  190 (89.62)   144 (81.36)  

%: Column percentage. *: p-value <0.05. **: p-value <0.01. ***: p-value <0.001

Note: <5 people reported undecided so were added to disagree.

4.6 Association between Organizational level factors (HPD climate and safety climate) and use of HPD

From the Pearson’s chi-square test of association, supervisors reminding workers to work safely when they are not doing so and supervisors saying good words to workers if they pay attention to safety were the two safety climate factors significantly associated with the use of HPD.

A high majority (89.3%) of the 177 workers who always use HPD agreed that their supervisors reminds them to work safely if they are not doing so, while 10.7% of them disagreed that their supervisors reminds them to work safely if they are not doing so.
Almost all (97.7%) of the 177 workers who always use HPD agreed that their supervisors say a good word to them if they pay attentions to safety while the remaining 4 failed to agree. (Table 4.5).

Table 4.5: Chi-square test of association of Organizational level factors (HPD climate and safety climate) on use of HPD

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>USE OF HPD</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sometimes</td>
<td>Always</td>
<td>chi-square</td>
<td>P-value</td>
<td></td>
</tr>
<tr>
<td>HPD CLIMATE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>My supervisor set a good example for the use of wear HPD</td>
<td>0.74</td>
<td>0.39</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>8 (3.77)</td>
<td>4 (2.26)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>204 (96.23)</td>
<td>173 (97.74)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hearing loss prevention from noise is important to my supervisor</td>
<td>1.68</td>
<td>0.195</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>10 (4.72)</td>
<td>4 (2.26)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>202 (95.28)</td>
<td>173 (97.74)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAFETY CLIMATE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>My supervisor frequently checks to see if safety rules are obeyed</td>
<td>0.07</td>
<td>0.796</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>4 (1.89)</td>
<td>4 (2.26)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>208 (98.11)</td>
<td>173 (97.74)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>My supervisor talks with workers on how to improve safety</td>
<td>0.004</td>
<td>0.949</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>5 (2.36)</td>
<td>4 (2.26)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>207 (97.64)</td>
<td>173 (97.74)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>My supervisor reminds me to work safely if I am not doing so.</td>
<td>5.06</td>
<td>0.024*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>10 (4.72)</td>
<td>19 (10.73)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>202 (95.28)</td>
<td>158 (89.27)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supervisor make sure that everyone follow safety rules</td>
<td>0.03</td>
<td>0.856</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>2 (0.94)</td>
<td>2 (1.13)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>210 (99.06)</td>
<td>175 (98.87)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>My supervisor says a 'a good word' to me if extra attention is paid to safety</td>
<td>7.02</td>
<td>0.008**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>18 (8.49)</td>
<td>4 (2.26)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>194 (91.51)</td>
<td>173 (97.74)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>My supervisor encourages me to wear my protective equipment, even if it is not comfortable</td>
<td>0.08</td>
<td>0.775</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>14 (6.6)</td>
<td>13 (7.34)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>198 (93.4)</td>
<td>164 (92.66)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

%: Column percentage. *: p-value <0.05. **: p-value <0.01. ***: p-value <0.001

Note: <5 people reported undecided so were added to disagree.
Composite means scores for Cognitive –Perceptual and organizational factors

Table 4.6 below shows summaries of scores obtained from the composite means scores of the cognitive-perceptual and organizational factors. Safety climate was the factor with the highest number of items (n=6) as well as scoring the highest Cronbach’s alpha score of 0.8124. The minimum composite mean score obtained by the respondents was 2.17 with a score of 5 being the highest. From a total of 389 respondents the mean of the composite mean score for safety climate was 4.38 on a possible scale of 1 to 5 with a standard deviation of 0.49. The minimum barrier composite mean score by a respondents was 1.00 whilst the highest score was 5.00 on a scale of 1.00 to 5.00. Also among the 389 respondents, mean composite mean score for barriers to the use of HPD was 3.87 with a standard deviation of 0.74. More on the summaries on the cognitive-perceptual and organizational level factors can be read from the table below.

Table 4.6: Composite means scores for Cognitive – Perceptual and organizational factors

<table>
<thead>
<tr>
<th>Cognitive-Perceptual factors/Organizational factors</th>
<th>*Number of items</th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitve- perceptual factors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-efficacy</td>
<td>3</td>
<td>4.36</td>
<td>0.49</td>
<td>2.67</td>
<td>5.00</td>
</tr>
<tr>
<td>Susceptibility</td>
<td>2</td>
<td>4.49</td>
<td>0.73</td>
<td>2.50</td>
<td>5.00</td>
</tr>
<tr>
<td>Severity of exposure</td>
<td>2</td>
<td>4.17</td>
<td>0.97</td>
<td>1.50</td>
<td>5.00</td>
</tr>
<tr>
<td>Benefits</td>
<td>3</td>
<td>4.10</td>
<td>0.58</td>
<td>2.33</td>
<td>5.00</td>
</tr>
<tr>
<td>Barriers</td>
<td>4</td>
<td>3.87</td>
<td>0.74</td>
<td>1.00</td>
<td>5.00</td>
</tr>
<tr>
<td>Interpersonal influences</td>
<td>3</td>
<td>3.95</td>
<td>0.58</td>
<td>1.67</td>
<td>5.00</td>
</tr>
<tr>
<td>Situational influences</td>
<td>3</td>
<td>3.73</td>
<td>0.65</td>
<td>2.33</td>
<td>5.00</td>
</tr>
<tr>
<td>Organizational factors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HPD climate</td>
<td>2</td>
<td>4.31</td>
<td>0.58</td>
<td>2.00</td>
<td>5.00</td>
</tr>
<tr>
<td>Safety climate</td>
<td>6</td>
<td>4.38</td>
<td>0.49</td>
<td>2.17</td>
<td>5.00</td>
</tr>
</tbody>
</table>


*The number of questions that make up the cognitive-perceptual and organizational variables
4.6 Predictors of HPD use among miners

In assessing the factors influencing the use of HPD among miners, the simple and multiple binary logistic regression model was fitted. From the Table below, the type of HPD use and interpersonal influences were the only factors that showed significant influence on the use of HPD among miners from the simple logistic regression model. All cognitive-perceptual and organizational level factors that had p-values less than 0.20 were introduced into the multiple logistic regression model whilst age group, highest level of education, number of years worked, and department of the respondents were also adjusted in the multiple binary logistic regression.

From the simple binary logistic regression model (Crude Odds ratio), workers who used ear muff had a significantly higher odds (Crude OR: 3.11, 95% CI: [1.96, 10.11], p-value: 0.039) of always using HPD as compared to workers who used ear plug. Also from the simple logistic regression model, workers who had higher composite mean scores in interpersonal influence had a significantly lower odds (Crude OR: 0.56, 95% CI: [0.39, 0.81], p-value: 0.002) of always using HPD as compared to those who had less composite mean scores in interpersonal relation.

From the multiple binary logistic regression model (Adjusted Odds ratio), cognitive-perceptual factor (interpersonal influences) and organizational factor (HPD climate) composite mean scores were the only two factors that were significantly associated with the use of HPD. For interpersonal influence, workers who had higher composite mean scores had significant lower odds (aOR: 0.52, 95% CI: [0.35, 0.78], p-value: 0.002) of always using HPD as compared to workers who had higher scores. For HPD climate, workers who had higher composite mean scores had significantly higher odds (aOR: 1.57, 95% CI: [1.03, 2.38], p-
value: 0.034) of always using HPD as compared to workers who had lower composite mean scores. (Table 4.7)

### Table 4.7: Logistic Regression of Predictors of HPD use among miners

<table>
<thead>
<tr>
<th>Variables</th>
<th>Crude Odds Ratio</th>
<th>Adjusted Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR (95% CI)</td>
<td>P-value</td>
</tr>
<tr>
<td>Age group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26-35 years</td>
<td>0.721</td>
<td>0.924</td>
</tr>
<tr>
<td>36-45 years</td>
<td>0.73 (0.41, 1.3)</td>
<td>0.87 (0.39, 1.93)</td>
</tr>
<tr>
<td>46-55 years</td>
<td>0.74 (0.40, 1.36)</td>
<td>0.76 (0.31, 1.88)</td>
</tr>
<tr>
<td>56-61 years</td>
<td>0.88 (0.36, 2.11)</td>
<td>0.74 (0.23, 2.39)</td>
</tr>
<tr>
<td>Highest level of education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>JHS</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>SHS</td>
<td>0.56 (0.23, 1.38)</td>
<td>0.60 (0.24, 1.56)</td>
</tr>
<tr>
<td>Diploma</td>
<td>0.79 (0.31, 2.05)</td>
<td>0.77 (0.28, 2.11)</td>
</tr>
<tr>
<td>Technical</td>
<td>0.89 (0.37, 2.13)</td>
<td>0.85 (0.32, 2.27)</td>
</tr>
<tr>
<td>Degree/masters</td>
<td>1.17 (0.47, 2.89)</td>
<td>1.06 (0.40, 2.83)</td>
</tr>
<tr>
<td>Number of years of mining</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;10 years</td>
<td>0.115</td>
<td>0.176</td>
</tr>
<tr>
<td>10-15 years</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>16-20 years</td>
<td>1.75 (0.66, 4.61)</td>
<td>2.63 (0.80, 8.62)</td>
</tr>
<tr>
<td>Department</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface operation</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Underground</td>
<td>1.28 (0.66, 2.45)</td>
<td>1.29 (0.64, 2.6)</td>
</tr>
<tr>
<td>Technical service</td>
<td>2.51 (1.23, 5.13)</td>
<td>2.49 (1.15, 5.42)</td>
</tr>
<tr>
<td>Processing</td>
<td>1.13 (0.55, 2.34)</td>
<td>1.04 (0.48, 2.26)</td>
</tr>
<tr>
<td>Engineering</td>
<td>1.51 (0.85, 2.69)</td>
<td>1.38 (0.69, 2.73)</td>
</tr>
<tr>
<td>Others*</td>
<td>2.43 (0.84, 7.05)</td>
<td>1.95 (0.61, 6.24)</td>
</tr>
<tr>
<td>Type of HPD use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ear plug</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Ear muff</td>
<td>3.11 (1.96, 10.11)</td>
<td>2.59 (0.75, 8.96)</td>
</tr>
<tr>
<td>Self-efficacy</td>
<td>1.15 (0.76, 1.73)</td>
<td>0.511</td>
</tr>
<tr>
<td>Susceptibility</td>
<td>0.90 (0.69, 1.19)</td>
<td>0.464</td>
</tr>
<tr>
<td>Severity of exposure</td>
<td>0.88 (0.72, 1.08)</td>
<td>0.227</td>
</tr>
<tr>
<td>Benefits</td>
<td>1.17 (0.83, 1.65)</td>
<td>0.380</td>
</tr>
<tr>
<td>Barriers</td>
<td>1.14 (0.87, 1.50)</td>
<td>0.334</td>
</tr>
<tr>
<td>Interpersonal influences</td>
<td>0.56 (0.39, 0.81)</td>
<td>0.002**</td>
</tr>
<tr>
<td>Situational influences</td>
<td>0.76 (0.56, 1.04)</td>
<td>0.088</td>
</tr>
<tr>
<td>HPD climate</td>
<td>1.26 (0.89, 1.79)</td>
<td>0.194</td>
</tr>
<tr>
<td>Safety climate</td>
<td>1.23 (0.82, 1.86)</td>
<td>0.314</td>
</tr>
</tbody>
</table>

OR: Unadjusted odds ratio. OR: adjusted odds ratio. CI: confidence interval. *: P-value<0.05. **: P-value<0.01. ***: P-value<0.001

*Workers who are not from the production departments but have offices located in the production departments.
CHAPTER FIVE

5.0 DISCUSSION

5.1 Main findings

Noise is one of the most widespread occupational hazards and NIHL is one of the most common occupational diseases. Although, hearing conservation programs are instituted in most work setting the issue NIHL continues to occur in noise-exposed employees. The study sought to assess the determinants of hearing protector device use among noise-exposed workers of Chirano Gold Mines Ltd. The response rate was 100%. The study established that 46% of the employees always use hearing protection device. Ear plugs were identified as the preferred HPD among the employees. None of the socio-demographic factors had a significant association with HPD use. Interpersonal influence and HPD climate were the cognitive-perceptual and organizational level factors respectively that had significant influence on the use of HPD (p-value <0.05).

5.2 Methodological Validity

The study has a number of strengths. There was a hundred percent participation rate among workers selected from all department of the mine and this has the potential of minimizing selection bias. The model used is a revised standardized model on Predictors’ of Workers Use of the Hearing Protection Model (PUHPM) adapted from Pender’s Health Promotional Model which is widely used and has been applied in many settings with results of reliability and validity (Mccullagh et al., 2002; Mccullagh, Ronis, & Lusk, 2010). Well-structured questionnaires based on the model were used to gather relevant data in order on the objectives of the study. These measures ensured that results reflected the true nature of the phenomenon under study. The findings of this study may be generalized as a true representation of the
entire population of Chirano Gold Mines on HPD use however since this study was conducted in only one mining company, findings may not be adequate for generalization to the entire mining companies in Ghana. Nonetheless, the researcher believes that the findings may not differ significantly from the experiences in other mining companies. This study is the first of its kind to have been done in Ghana.

Limitations of the study included exclusion of casual mine workers and contractors. Gender bias was an issue though most mining company workers are predominantly males this study assume such status. The analysis of gender on HPD use and model variables was severely limited due the fact that no female was selected severely limited. Future research and data collection approaches should include methods that ensures a greater proportion of females in the study.

5.3 Comparison with previous studies

5.3.1 Use of hearing protection device (HPD)

This study highlighted that to predict the use of HPDs among noise-exposed workers of Chirano Gold Mines the Predictors’ of Workers Use of the Hearing Protection Model (PUHPM) could be used. The results from this study is an indication that the model accurately classified 100% HPD use. The percentage of users of HPD always precisely classified was 46%, and the percentage of sometimes users correctly classified was 54%. Participants who reported less frequent use of HPDs gave reasons such as it was uncomfortable using them, never thought about the likely effects of not using HPDs and not spending much time in noisy environment. The results of this study are inconsistent with studies previously done, which established that the PUHPM predicted 70.1% of HPD use among noise-exposed Thai workers (Tantranont & Codchanak 2017). The result of this study is dissimilar to another study by
Hong et al., (2005) in which 12% difference in use of HPD amongst Black employees and 36% of the difference in use of HPD amongst white personnel was established. Same was true of a study by Raymond et al. (2006) which reported that the PUHPM classified 20% and 37% of the difference in use of HPD amongst Hispanic and non-Hispanic workers respectively. The findings of HPD ownership confirms the findings of another study which found 100% ownership of HPDs (Ntlhakana & Kanji, 2015). Reasons being that there is a strict safety regulation in most mines and these mines appear to have opted to use them as the main preventive measure, rather than other noise reduction measures such as engineering controls. Reasons include easy accessibility of HPDs, lower costs, and ease of use (Ntlhakana & Kanji, 2015). The findings of this study is inconsistent with studies in developed countries such as the US where the results indicated that noise-exposed workers used HPDs only 14% to 49% of the time when required (Hong, 2005; Lusk, Kerr, & Kauffman, 1998). Same is true of a study in Thailand where literature from other studies for example, reported that only 29% to 41% of workers exposed to noise used HPDs continuously and these workers were from industries such marble, the pressing, food canning and lumber mills (Khrimak, 1997; Tonchumporn, 2007).

This findings was also confirmed by Reddy, Welch, Ameratunga &Thorne (2014) as they reported an observed wide range in reported HPD use when workers were exposed to noise, with 46% of participants reporting they always wore HPDs and 54% reporting not always wearing HPD (22% almost always, 12% usually, 4% often, 12% sometimes and 4% rarely or never). This study findings are inconsistent with a study by Landen, Wilkins, Stephenson, and McWilliams (2004) which found that 48% of these miners they sampled never used hearing protectors.
5.3.2 Predictors of the use of HPD

None of the demographic characteristics showed significance association with the use of HPD. This finding contradicts that of Lusk *et al.* (1994) who reported that value of use, perceived barriers to hearing protector use, self-efficacy, situational factors, gender, and age as predictors of HPD use by using a structural equation modeling. The findings of this study is inconsistent with the findings of Raymond *et al.*, (2006); Sbihi *et al.*, (2010) which indicated that increased noise levels in the workplace, once age (young being), peers and supervisors influence and particularly, being male, regardless of occupation is positively associated with HPD use. The study findings is also inconsistent with the findings of a study by McCullagh, Banerjee, Cohen and Yang (2016) which indicated that age of the participants was a significant predictor for situational influences and interpersonal modeling. Older participants were more likely to report more situational influences and interpersonal modeling on HPD use.

Interpersonal influence and HPD climate were the cognitive-perceptual and organizational level factors respectively that were significantly associated with HPD use in this group. This finding is consistent with the results of the study by Tantranont, & Codchanak (2017) which revealed that “interpersonal influences” items had statistically significant correlations with HPD use. The findings of this study is also similar to a study according to McCullagh, Lusk, & Ronis, (2002), which found that interpersonal influences of HPD use and situational influences to use of HPDs correctly predicts ones use of HPD in 78% of all cases. The findings of this study is also similar to the findings of previous studies which reported that interpersonal influences predicted the use of HPDs among exposed White workers and firefighters (Hong *et al.*, 2005; Hong *et al.*, 2013). It was indicated in this study that, the
strong interpersonal influence on HPD use reflected exceptional work philosophy that valued learning on the job and motivation from others such as colleagues and superiors.

It was interesting to note that perceived benefits, perceived barriers and self-efficacy as revealed in the literature to be strong predictors of HPD use were not significantly related to HPD use amongst the employees involved in this study. The difference may be due to features of the study participants and also the instruments employed may have had overall effect on the results.

The findings in this study on HPD climate being a predictor of HPD use is similar to the reports by Edelson et al., (2009), which stated that workers’ attitudes and beliefs toward HPD use, based on the HPM by Pender were significant predictors of HPD use. The findings are similar to the findings by Vinodkumar and Bhasi (2010) which indicated that when management is committed to safety rules and procedures it predicts safety compliance directly whereas safety training to the workers and safety communication and positive feedback predicted safety compliance indirectly.
CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATION

6.1 Conclusion

The findings established that all the workers use hearing protectors. However, 46% of the participants use hearing protection device (HPD) always whiles the remaining, 54% use HPD sometimes, presumably, a better protection for the always users. Furthermore, a high majority (96%) of the study participants preferred to use ear plugs as compared to the few (4%) that preferred ear muff, this trend can be attributed to the availability of ear plugs as compared to muffs. Interpersonal influence and HPD climate were the cognitive-perceptual and organizational level factors respectively that had significant association on the use of HPD. HPDs are mainly the last means by which employees are protected from noise and its adverse effects, when it is seemingly impossible to eliminate the source of noise completely.

6.2 Recommendation

The study recommends a daily noise exposure program that monitor individual worker’s noise exposure inside the worker’s hearing protection. Workers who are frequently alerted to their true occupational noise exposures can play an active role in optimizing the use of hearing protection devices to reduce exposures. Since evidence in the literature suggests that daily noise monitoring intervention assessment may be effective in reducing hearing loss, there should be alternative technological ways to achieve the same result, such as the use of ambient dosimeters with warning devices worn on the shoulder to alert workers to excessive noise exposures in their working environment.

Training and re-training programs that is tailored towards workers needs on hearing protection. Workers comfort and preferences should be highly considered during training
programs on HPD use. Training should be adequate and provide the needed understanding on hearing protection devices, maintenance and proper care.

Management must be up to task such that policies and regulations on hearing protection device use will be strengthened and punitive measures will be put in place to deter offenders. Supervisors should be vigilant and alert to ensure compliance on HPD use among the workers, especially when a large chunk of employees reported not always using HPDs. There should be felt-leadership where workers see and can talk to their supervisors on safety-related issues. Policies and regulations on HPD use must be strengthened and workers have to be empowered to own the policies. There should also be adequate training and retraining of workers on the advantages as well as consequences for not using HPDs.

Adequate engineering and administrative controls to reduce noise at source in order to reduce exposure and NHIL risk. Hearing Conservation Program has to be stricter and more strengthened to meet employees’ demand, where employees with problems will be monitored quarterly or annually to assess them. There should be enough interventional programs to promote the use of Hearing protector device in the work place.
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APPENDICES

Appendix 1: INFORMED CONSENT FORM

CONSENT FORM

Form number [ ]

Project Title: The Determinants of Hearing Protector Device use among Noise-Exposed Workers of Chirano Gold Mines.

Name and address of Principal Investigator

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Institution affiliated

School of Public Health, University of Ghana, Legon, Accra

Introduction

I am a student from the School of Public Health, University of Ghana conducting a research on the Determinants of Hearing Protection Device use Among Noise-Exposed Workers of Chirano Gold Mines. The rationale behind this project is to assess the predictors of hearing protection device use among miners. All information collected will be treated as confidential and no one will be able to trace any information back to you.
Procedure
Data collection will be done in a day. The study requires you to answer few questions on hearing protector use and the factors or determinants predicting its uses.

Possible Risks
The risk to you by participating is minimal. The only discomfort associated with this study is time needed to fill out the questionnaire. You will not be judged by the answers you provide by anyone related to the study neither will the answers you give have a negative effect on your current and future management.

Possible Benefit(s):
Direct benefit will not be obtained from the questionnaire, however the information provided by you and other clients will aid in the formulation of strategies for effective occupational surveillance. You are at liberty to ask any questions concerning the procedure during the testing.

Anonymity and Confidentiality
Be assured that any information given will be used purely for the purpose of this research. Any information given will be treated with utmost confidentiality.

Compensation
There will be no compensation in any form water or soft drinks will be given as a refreshment.
Voluntary Participation and Right to Leave the Research

Your consent to participate in this study is voluntary, you are not under any obligation to do so, and you are at liberty to withdraw from this study at any point in time.

Your rights as a Participant

This research has been reviewed and approved by the Ethical Review Committee of the Ghana Health Service. If you have any questions about your rights as a research participant you can contact the Ethical Review Coordinator on 0507041223 (Ms. Hannah Frimpong).
Appendix 2: VOLUNTEER AGREEMENT

The above document describing the benefits, risks and procedures for the research title *The Determinants of Hearing Protection Device use Among Noise-Exposed Workers Of Chirano Gold Mines* has been read and explained to me. I have been given an opportunity to have any questions about the research answered to my satisfaction. I agree to participate as a volunteer.

_________________________  ________________________________
Date  Name and signature or mark of volunteer

If volunteers cannot read the form themselves, a witness must sign here:

I was present while the benefits, risks and procedures were read to the volunteer. All questions were answered and the volunteer has agreed to take part in the research.

_________________________  ________________________________
Date  Name and signature of witness

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual.

_________________________  ________________________________
Date  Name Signature of Person Who Obtained Consent
Appendix 4: QUESTIONNAIRE

THE DETERMINANTS OF HEARING PROTECTOR DEVICE USE AMONG
NOISE-EXPOSED WORKERS OF CHIRANO GOLD MINES

INSTRUCTION: Please provide the correct response(s) to the questions by ticking (✓) in the space provided.

Socio-demographic Data

1. Educational level: ( ) JSS ( ) SHS ( ) Diploma ( ) Technical ( ) Degree ( ) Masters ( ) PHD. Others, specify: ..............................

2. Gender  ( ) Male  ( ) Female

3. Years' experience in mining (duration of mining experience) ( ) 1-3 ( ) 4-6 ( ) 7-9 ( ) 10+

Health-Promoting Behavior

(Use of Protective Hearing Device)

1. Do you use protective hearing device when working?  ( ) Yes  ( ) No

2. If yes, how often do you wear it? ( ) Always ( ) Sometimes

2B. If not always, what is the reason? ( ) It is uncomfortable ( ) Never thought about it ( ) It’s unnecessary ( ) Limited knowledge ( ) Do not spend much time working in noisy environment

3. What type of HPD do you use? ( ) Ear plug  ( ) Ear muff
Self-efficacy

1. I know when I need to wear my hearing protection.
   A. ( ) Strongly Disagree
   B. ( ) Disagree
   C. ( ) Undecided
   D. ( ) Agree
   E. ( ) Strongly Agree

2. I know how to wear my hearing protection correctly
   A. ( ) Strongly Disagree
   B. ( ) Disagree
   C. ( ) Undecided
   D. ( ) Agree
   E. ( ) Strongly Agree

3. I have a hard time wearing protection, I am sure I can ask for help
   A. ( ) Strongly Disagree
   B. ( ) Disagree
   C. ( ) Undecided
   D. ( ) Agree
   E. ( ) Strongly Agree

Susceptibility

1. If I don’t wear hearing protection, my hearing will not be affected.
   A. ( ) Strongly Disagree
   B. ( ) Disagree
2. My hearing can be hurt by exposure to loud noise.
   A. ( ) Strongly Disagree
   B. ( ) Disagree
   C. ( ) Undecided
   D. ( ) Agree
   E. ( ) Strongly Agree

Severity of exposure

1. If I lost some of my hearing, it would be harder for me to understand what people
   A. ( ) Strongly Disagree
   B. ( ) Disagree
   C. ( ) Undecided
   D. ( ) Agree
   E. ( ) Strongly Agree

2. If I lost some of my hearing, it wouldn’t be a big problem for me
   A. ( ) Strongly Disagree
   B. ( ) Disagree
   C. ( ) Undecided
   D. ( ) Agree
   E. ( ) Strongly Agree
Benefits

1. Hearing loss prevention is important to me
   A. ( ) Strongly Disagree
   B. ( ) Disagree
   C. ( ) Undecided
   D. ( ) Agree
   E. ( ) Strongly Agree

2. Wearing HPDs gives me protection against hearing loss from noise
   A. ( ) Strongly Disagree
   B. ( ) Disagree
   C. ( ) Undecided
   D. ( ) Agree
   E. ( ) Strongly Agree

3. I can be able to hear machinery or talk to coworkers when I wear HPDs
   A. ( ) Strongly Disagree
   B. ( ) Disagree
   C. ( ) Undecided
   D. ( ) Agree
   E. ( ) Strongly Agree

Barriers

1. It is harder to talk to people when I wear HPDs
   A. ( ) Strongly Disagree
   B. ( ) Disagree
C. ( ) Undecided
D. ( ) Agree
E. ( ) Strongly Agree

2. HPD use is time consuming.
   A. ( ) Strongly Disagree
   B. ( ) Disagree
   C. ( ) Undecided
   D. ( ) Agree
   E. ( ) Strongly Agree

3. Wearing hearing protection is unsafe because it blocks out danger signals.
   A. ( ) Strongly Disagree
   B. ( ) Disagree
   C. ( ) Undecided
   D. ( ) Agree
   E. ( ) Strongly Agree

4. HPD use is uncomfortable for me.
   A. ( ) Strongly Disagree
   B. ( ) Disagree
   C. ( ) Undecided
   D. ( ) Agree
   E. ( ) Strongly Agree
Interpersonal influences

1. Hearing protection is used by other workers when it’s noisy.
   A. ( ) Strongly Disagree
   B. ( ) Disagree
   C. ( ) Undecided
   D. ( ) Agree
   E. ( ) Strongly Agree

2. When I need to wear hearing protectors, other workers remind me.
   A. ( ) Strongly Disagree
   B. ( ) Disagree
   C. ( ) Undecided
   D. ( ) Agree
   E. ( ) Strongly Agree

3. Colleagues at this site make fun of me when using hearing protection.
   A. ( ) Strongly Disagree
   B. ( ) Disagree
   C. ( ) Undecided
   D. ( ) Agree
   E. ( ) Strongly Agree

Situational influences

1. Hearing protectors are available at this site.
   A. ( ) Strongly Disagree
   B. ( ) Disagree
2. I can choose from several types of hearing protectors at this site.
   A. ( ) Strongly Disagree
   B. ( ) Disagree
   C. ( ) Undecided
   D. ( ) Agree
   E. ( ) Strongly Agree

3. My supervisor encourages me to wear hearing protection, even when my noise exposure is short.
   A. ( ) Strongly Disagree
   B. ( ) Disagree
   C. ( ) Undecided
   D. ( ) Agree
   E. ( ) Strongly Agree

**HPD climate**

1. My supervisor sets a good example for me when it comes to hearing protection.
   A. ( ) Strongly Disagree
   B. ( ) Disagree
   C. ( ) Undecided
   D. ( ) Agree
2. Hearing loss prevention is very important to my supervisor.
   A. ( ) Strongly Disagree
   B. ( ) Disagree
   C. ( ) Undecided
   D. ( ) Agree
   E. ( ) Strongly Agree

Safety climate

1. My supervisor frequently checks to see if safety rules are being obeyed.
   A. ( ) Strongly Disagree
   B. ( ) Disagree
   C. ( ) Undecided
   D. ( ) Agree
   E. ( ) Strongly Agree

2. The supervisor talks with workers about how to improve safety.
   A. ( ) Strongly Disagree
   B. ( ) Disagree
   C. ( ) Undecided
   D. ( ) Agree
   E. ( ) Strongly Agree

3. My supervisor reminds me to work safely if I am not doing so.
   A. ( ) Strongly Disagree
4. The supervisor makes sure that everyone follow all the safety rules.
   A. ( ) Strongly Disagree
   B. ( ) Disagree
   C. ( ) Undecided
   D. ( ) Agree
   E. ( ) Strongly Agree

5. The supervisor says a ‘good word’ to me if extra attention taken is on safety.
   A. ( ) Strongly Disagree
   B. ( ) Disagree
   C. ( ) Undecided
   D. ( ) Agree
   E. ( ) Strongly Agree

6. My supervisor encourages me to wear my protective equipment, even if it is not comfortable.
   A. ( ) Strongly Disagree
   B. ( ) Disagree
   C. ( ) Undecided
   D. ( ) Agree
   E. ( ) Strongly Agree