

https://dspace.org/

THE USE OF HEARING PROTECTION

HANSIA, MOHAMMED RASHAAD

2011-04-13
http://hdl.handle.net/10539/9442

Downloaded from a DSpace repository. https://dspace.org/

RESEARCH REPORT

THE USE OF HEARING PROTECTION DEVICES BY UNDERGROUND GOLD MINERS IN SOUTH AFRICA

MOHAMMED RASHAAD HANSIA

31st August 2006
Johannesburg

DECLARATION

I, Mohammed Rashaad Hansia, declare that this report is my own work. It is being submitted for the Degree of Master of Business Administration at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

_____

_____ day of _____, 2006.

DEDICATION

To my family, past, present and future.

ACKNOWLEDGEMENTS

I wish to acknowledge the assistance of the employees and management at the mine at which the study was conducted including the Senior Manager Occupational Environment and his team in the Occupational Hygiene department without whose assistance the research would have been very difficult to complete. I also wish to acknowledge the support of the Senior Consultant Occupational Environment and the Occupational Environmental Consultant of the mining company.

I wish to acknowledge the assistance of Dr Anthony Stacey with regard to statistical analysis of results and my supervisor, Dr David Dickinson whose assistance, advice, support and intellectual debates helped to shape the research.

SUMMARY

NAME:	MOHAMMED RASHAAD HANSIA
QUALIFICATIONS:	MBBCh MPH DOH (WITS)
STUDENT NUMBER:	9001435F
DEPARTMENT:	Graduate School of Business Administration University of the Witwatersrand
COURSE REGISTERED FOR:	Masters in Business Administration (MBA)
TITLE OF RESEARCH:	The use of hearing protection devices by underground gold miners
SUPERVISOR:	Dr. David Dickinson – Graduate School of Business Administration - University of the Witwatersrand (Wits Business School - Johannesburg)

SUMMARY:

Background
Studies indicate that exposure to harmful sound levels are common in industrial workers. Noise induced hearing loss (NIHL) is a consequence of long term exposure to excessive levels of noise and results in both significant morbidity amongst persons with NIHL and economic costs to industry. NIHL has been shown to be preventable by attenuating noise exposure with the sustained use of hearing protection devices (HPDs).

Statement of the Problem
Underground gold miners are known to be exposed to high noise levels from machinery and equipment used in the course of their work. Despite hearing conservation programmes (HCPs), which promote the use of HPDs and the provision of HPDs to all employees free of charge, NIHL continues to occur amongst underground gold miners. This study set out to determine the uptake of usage of HPDs and ascertain the knowledge, attitudes and practices relating to NIHL and the use of HPDs in underground gold miners in South Africa.

Study Methods
This study was done by measuring HPD usage through observation of a statistically significant, representative, randomly selected sample of noise-exposed mine workers as well as structured interviews with these mine workers in a cross sectional descriptive study. The study was undertaken at an underground gold mine west of Johannesburg. All results were anonymous and unlinked and treated confidentially. No tests were carried out on subjects.

Findings
Ninety three per cent of respondents reported using HPDs but only 50% were observed to be using these devices. Thirty per cent of respondents reported not using HPDs consistently and 58% of respondents reported not using HPDs continuously during exposure to hazardous noise. Participants' knowledge regarding NIHL and HPD usage is good in terms of: reported knowledge of the potential of noise to damage hearing

(82%); knowledge of the benefits of using HPDs (89%); and the correct perception of the workplace as 'noisy' (84%). However, a significant minority reported a lack of knowledge of the benefits of HPDs and the correct perception of their workplaces as being noisy, despite apparently having been through the relevant education programmes on several occasions. Attitudes towards NIHL and HPD usage were generally good in the study sample as evidenced by: a reported high prioritisation of NIHL (86% of respondents reported NIHL as being as important or more important than other workplace injuries and illnesses); the self-assumed responsibility for NIHL (92% reported that NIHL was the responsibility of miners themselves); and the indicated impression that the perceptions around NIHL could be changed (68% of respondents indicated that something could be done to improve the use of HPDs). Further problems with the current system of education around NIHL and HPDs at this mine are inferred by the indicated preference of the majority of respondents for means of education other than the current computer-enabled education (57% of responses) and for educators other than the current training staff (66% of responses).

Reported reasons for not using HPDs were mainly discomfort (50%); perceived interference of HPDs with hearing warning signals (23%); the impression that HPDs did not work (13%); and devices reportedly falling out of the ears during use (10%). Failure to use HPDs is compounded by actual or perceived barriers to access to HPDs in terms of unavailability of these devices (6% of respondents), refusal to access to them (5% of respondents), and a lack of variety of HPDs to choose from (32%). All of these factors are also exacerbated by a system supported by supervisory checks on the use of HPDs but which does not promote the checking of use by co-workers ('hands off' culture). The checking on use of HPD usage by supervisors only, implies a 'top down' approach rather than positive reinforcement of health-maintaining behaviour such as the use of HPDs.

Conclusion

This study has found a much higher rate of reported HPD usage than observed usage in a statistically significant sample of underground gold miners with demographic characteristics representative of the study population. It is recommended that the current training programme with regard to NIHL and HPDs be reviewed, complementary methods of training and alternate educators and trainers be considered, the emphasis on prevention be increased, and actual and perceived barriers to access to HPDs be removed, in order to address these findings.

TABLE OF CONTENTS

DECLARATION....2

DEDICATION....3

ACKNOWLEDGEMENTS....4

SUMMARY....5

TABLE OF CONTENTS....7

LIST OF TABLES....10

1 INTRODUCTION....12
1.1 Definition of Terms....12
1.2 Background Information....13
1.3 Research Questions....14
1.3.1 What proportion of noise-exposed underground gold miners interviewed use hearing protection devices at work (actual and reported use)?....14
1.3.2 What is the level of knowledge regarding the use of hearing protection devices amongst underground gold miners?....14
1.3.3 What are the attitudes of underground gold miners towards noise induced hearing loss and the use of hearing protection devices?....14
1.3.4 What are the factors affecting the use of hearing protection devices by underground gold miners?....14
1.3.4.1 Comfort of hearing protection devices;....14
1.3.4.2 Danger signals....14
1.3.4.3 Other reasons.....14

2 LITERATURE REVIEW....15
2.1 Sound and the Human Ear....15
2.2 Hearing Protection Devices....16
2.3 Magnitude of the Problem....17
2.4 Reasons for Failure of Hearing Conservation Programmes....19
2.5 Uptake of Usage of Hearing Protection Devices....20
2.6 Knowledge Regarding Noise Induced Hearing Loss and Hearing Protection Device usage....21
2.7 Attitudes towards Noise Induced Hearing Loss and Hearing Protection Device Usage 23
2.8 Reasons for not Using Hearing Protection Devices....24
2.9 Justification for the Study....26

3 METHODOLOGY....27
3.1 Study Site Description....27
3.2 Study Population....27
3.3 Study Sample....27
3.4 Sample Size Calculation:....28
3.5 Measurement....28

3.5.1 Study design 28
3.5.2 Variables measured 28
The following variables were measured in this study: 28
3.5.2.1 Knowledge, attitudes & practices relating to NIHL and HPD usage 28
3.5.2.2 Use of hearing protection devices 29
3.5.3 Data collection techniques 29
3.5.4 Data collation 29

4 ASSUMPTIONS 30

5 POSSIBLE LIMITATIONS 31

6 ETHICAL CONSIDERATIONS 32

7 DATA PROCESSING AND DATA ANALYSIS 33

8 RESULTS AND ANALYSIS 34
8.1 Demographic Data 35
8.2 Hearing Protection Device Usage 36
8.2.1 Reported versus observed use of hearing protection devices 36
8.2.2 Consistency of use of hearing protection devices 37
8.2.3 Continuity of use of hearing protection devices 38
8.2.4 Summary of findings relating to the use of hearing protection devices 39
8.3 Knowledge of Respondents 40
8.3.1 Knowledge of noise as a hazard 40
8.3.2 Knowledge of the benefits of using hearing protection devices 41
8.3.3 Perception of work environment 44
8.3.4 Knowledge of insertion, cleaning and storage of hearing protection devices 45
8.3.5 Summary of findings relating to reported knowledge of NIHL and the use of hearing protection devices 46
8.4 Attitudes towards Noise Induced Hearing Loss and the Use of Hearing Protection Devices 47
8.4.1 Relative importance of noise induced hearing loss compared with other workplace injuries and illnesses 47
8.4.2 Responsibility for noise induced hearing loss 48
8.4.3 Reasons for using hearing protection devices 49
8.4.4 Influencing the use of hearing protection devices 50
8.4.5 Preference for method of education regarding hearing protection devices 50
8.4.6 Preference for who should carry out the educating 51
8.4.7 Summary of findings relating to reported attitudes of participants towards noise induced hearing loss and the use of hearing protection devices 52
8.5 Factors affecting the Use / Non-use of Hearing Protection Devices 52
8.5.1 Availability of hearing protection devices amongst miners interviewed 53
8.5.2 Access to hearing protection devices 53
8.5.3 Availability of hearing protection devices free of charge 54
8.5.4 Availability of a range of hearing protection devices 55
8.5.5 Summary of findings relating to factors affecting the use / non-use of hearing protection devices 55

8.6 Reported Reasons for not Using Hearing Protection Devices 56
8.6.1 Reported reasons for not using hearing protection devices 56
8.6.2 Supervision of hearing protection device usage 57
8.6.3 Summary of findings relating to reasons for not using hearing protection devices 59
8.7 Summary of Results and Analysis 60

9 CONCLUSION 61
9.1 Hearing Protection Device Usage 61
9.2 Knowledge 61
9.3 Attitudes 64
9.4 Reasons for not using Hearing Protection Devices 64

10 RECOMMENDATIONS 67
10.1 Recommendations Relating to Increasing Usage 67
10.1.1 Review of the current education and training programme 67
10.1.2 Consider complementary methods of training 68
10.1.3 Consider alternative educators and trainers 69
10.1.4 Increased emphasis on prevention 70
10.2 Recommendations Relating to Removing Barriers to Usage 70

11 SUGGESTED FURTHER RESEARCH 71

12 REFERENCES 72

APPENDIX A - NIHL AND HPD QUESTIONNAIRE 75

APPENDIX B - Subject Information Form for Participants 83

APPENDIX C - Consent Form for Individual Participants 84

APPENDIX D – Comprehensive List of Recommendations 85

LIST OF TABLES

Table 1 Demographic Variables of Participants and Workforce 35

Table 2 Hearing Protection Device Usage 36

Table 3 Reported Consistency of Hearing Protection Device Usage 38

Table 4 Reported Continuity of Hearing Protection Device Usage 39

Table 5 Reported Knowledge of Noise as a Hazard 40

Table 6 Perception of the Benefits of Using Hearing Protection Devices 41

Table 7 Explanation of the Benefits of Hearing Protection Devices 42

Table 8 Who Explained the Benefits of Hearing Protection Devices 43

Table 9 Perception of Work Environment 44

Table 10 Cross-tabulation Report of Perception of Work Environment versus Reported Self-use of Hearing Protection Devices 44

Table 11 Reported Knowledge of Hearing Protection Device Insertion, Cleaning and Storage 46

Table 12 Reported Relative Importance of NIHL 47

Table 13 Reported Responsibility for Miners' Hearing 48

Table 14 Reported Perceived Benefits of Using Hearing Protection Devices 49

Table 15 Reported Opinion on whether Anything could be done to Influence the Use of Hearing Protection Devices amongst Miners 50

Table 16 Miners' Preferred Medium of Education on Hearing Protection Device usage 51

Table 17 Preference for Who should carry out the Hearing Protection Device Education 51

Table 18 Reported Availability of Hearing Protection Devices 53

Table 19 Reported Refusal of Access to Hearing Protection Devices 53

Table 20 Cross-tabulation Report of Availability of Hearing Protection Devices versus Refusal of Access to Hearing Protection Devices 54

Table 21 Availability of Hearing Protection Devices Free of Charge 54

Table 22 Availability of More than one Type of Hearing Protection Device 55

Table 23 Reported Reasons for not Using Hearing Protection Devices 56

Table 24 Supervision of Hearing Protection Device Usage 57

Table 25 Who Supervises the Use of Hearing Protection Devices 58

1 INTRODUCTION

1.1 Definition of Terms

In this study the definitions below apply to the terms used in the text.

Noise induced hearing loss: is a loss of hearing as a result of irreversible damage to the hearing apparatus of both ears caused by long term exposure to noise greater than 85 dB in intensity. NIHL usually mainly affects certain frequencies with a specific hallmark of being a permanent decrease in hearing sensitivity from 3000 to 6000 Hz (Crandell, Mills & Gauthier 2004).

Sound: is the audible perception resulting from the mechanical movement or excitation of mechanisms or machinery at a frequency of 20 to 20 000 Hz (Franz & Phillips 2001).

Noise: is sound which interferes with ability to communicate or which has the potential to adversely affect human hearing (Franz & Phillips 2001).

1.2 Background Information

Long term exposure to noise levels above 85 decibels – time weighted average (dB (A)) has been known for many years to result in noise induced hearing loss (NIHL). The Chamber of Mines Research Organisation (COMRO) described this phenomenon as far back as 1974, followed by others such as Kahan & Ross (1992). Such exposure and consequent impairment are common in industries in which workers are exposed to such noise levels and the association between certain occupations and NIHL has been described in boilermakers and blacksmiths as long ago as the 19th century as reported by Shearer (1992).

Mining in general and gold mining in particular by their very nature require the use of noise-generating equipment, which can result in NIHL (Van Rensburg, Strydom & Kielblock 1981; Kahan & Ross 1994; Kielblock 1999). However, NIHL is largely preventable in general by reducing the noise to which a worker is exposed (Pessina & Gueretti 1999) and, specifically, through the consistent use of hearing protection devices (Lusk & Keleman 1993).

South African legislation outlines how occupational exposures such as excessive noise which causes NIHL should be addressed, in the Mines Health and Safety Act (MHSA - 1996). This legislation stipulates that exposure of workers to noise should be eliminated or minimised as far as is reasonably practicable by eliminating the hazard at source, using engineering controls to minimise intensity of exposure, employing administrative controls to minimise duration of exposure, and providing personal protective equipment (PPE) to individuals still exposed. In addition to these interventions, the need is legislated for employers to implement HCPs for workers. These programmes are intended to create awareness of and educate individuals on the health consequences of prolonged exposure to excessive noise, and the use of PPE. Furthermore, this legislation also stipulates medical surveillance of exposed employees to detect NIHL as early as possible (where such interventions have failed), and submit cases for compensation.

Yet, despite compliance with this legislation and the establishment of HCPs in the gold mining industry, NIHL continues to occur, suggesting a failure of the HCPs. The consequent continued incidence of NIHL with its related morbidity and economic costs made this research important in informing recommendations for improving current HCPs.

1.3 Research Questions

This research aimed to determine the uptake of HPD usage in noise-exposed Witwatersrand gold miners and their reported knowledge, attitudes and practices relating to NIHL and the use of HPDs. These parameters were assessed through the following research questions:

1.3.1 What proportion of noise-exposed underground gold miners interviewed use hearing protection devices at work (actual and reported use)?

1.3.2 What is the level of knowledge regarding the use of hearing protection devices amongst underground gold miners?

1.3.3 What are the attitudes of underground gold miners towards noise induced hearing loss and the use of hearing protection devices?

1.3.4 What are the factors affecting the use of hearing protection devices by underground gold miners? These were explored in terms of:

1.3.4.1 Comfort of hearing protection devices;

1.3.4.2 Danger signals (it is anecdotally reported that sounds emanate from rock under high stresses and that hearing protection devices may interfere with hearing these sounds); and

1.3.4.3 Other reasons.

2 LITERATURE REVIEW

2.1 Sound and the Human Ear

The normal human ear is able to distinguish sound at a range of frequencies. Loss of perception at any of these frequencies results in a functional impairment ranging from mild hearing loss to total deafness (Franz & Phillips 2001). Sound is measured at each frequency on an intensity scale expressed in decibels (dB). The higher the dBs at any given frequency, the greater the sound intensity and, consequently, the greater the potential for hearing damage. Whilst exposure to sound per se does not detrimentally affect hearing, excessive exposure to high intensities of noise does. The generally accepted level of noise that is likely to result in hearing loss over time is 85 dB (A) (Franz & Phillips 2001). Furthermore, since the aforementioned scale of measurement of sound intensity (dB) is a logarithmic one, the dosage of exposure in terms of pressure level increases exponentially relative to perceived sound intensity or loudness. Hence a time-weighted average (TWA) of daily dose exposure to sound or noise is commonly used. This TWA takes into account the fact that higher than recommended exposure results in an exponentially lower allowable time of exposure. For example, beyond the 85 dB (A) level, every 3 dB increase in noise exposure requires a 50% reduction in exposure time. Thus it is generally held that a person exposed to 85 dB of sound may be exposed for an average eight-hour shift without detrimental health consequences, yet the same individual would be advised to endure an only four-hour shift at 88 dB or an only two-hour shift at 91 dB exposure before damage is likely to occur.

Excessive exposure to noise has the potential to damage hearing in one of two ways. First, exposure to sound above 105 dB causes damage to hearing apparatus in the middle ear. This condition, referred to as “acute noise overexposure”, results in irreversible damage to the hearing apparatus of the ear (different to noise induced hearing loss - NIHL) and is not dealt with any further in this paper. Second, long-term exposure to noise dosages above 85 dB (A) causes irreversible hearing loss at certain frequencies (Crandell, Mills & Gauthier 2004). This condition is referred to as NIHL and can be a serious and debilitating condition as a result of irreversible damage to the hearing apparatus of the ear. A specific hallmark of NIHL is a permanent decrease in hearing, specifically at the

3000 to 6000 Hz frequencies, which in severe cases results in profound deafness (Crandell, Mills & Gauthier 2004). Such noise exposure is relatively common in industries where noise-generating machinery and equipment is used, such as gold mining.

2.2 Hearing Protection Devices

It has also long been documented that attenuating the intensity of the sound exposure reduces the likelihood of hearing loss developing. In its simplest form, this is achieved by occlusion of the auditory canal to prevent the transmission of noise to the sensitive and vulnerable hearing apparatus through the use of mechanical devices such as earmuffs or earplugs. These devices act in a mechanical manner, attenuating the perceived noise level, thus reducing the risk of NIHL.

This practice is supported by the findings of Axelsson, Axelsson & Jonsson (1978) in a study of hearing loss in workers. They found that those workers with normal hearing had used hearing protection devices (HPDs) considerably more than those with severe hearing loss. Neitzal & Seixas (2005) also found that HPDs were able to achieve a more than 50% attenuation of noise exposure on average, but that variability of attenuation achieved using this apparatus was high. Even so its use was a significant barrier to noise.

Leinster, Baum, Tong & Whitehead (1994) found that there was a need for more education and motivation of senior managers as to the urgency of improving standards of hearing conservation and noise control.

Whilst NIHL may be prevented at an individual level by the use of HPDs, the actual use of such HPDs is a complex practical problem requiring awareness of the ability of noise to cause damage to hearing, education as to its preventability, instruction on the correct method and habit of use of the devices and testing of the correctness of use of HPDs whenever exposed to harmful noise. Such formalised endeavours to prevent NIHL through a combination of these preventive actions in workplace (as well as in civil society) are referred to as hearing conservation programmes (HCPs). This approach to hearing protection through an HCP usually comprises strategies to prevent damage from sound

exposure; including the use of individual HPDs; education programmes beginning with school-age children; consumer guidance; increased product noise labelling; and hearing conservation programmes for occupational settings.

Despite the fact that HCPs have been part of South African mines since 1994 (Franz & Phillips 2001), NIHL continues to occur. This persistence of NIHL despite industry interventions points to a failure of the HCPs. However, this failure is not unique to the mining industry. For example, Neitzal & Seixas (2005) have concluded that effective hearing conservation programmes (HCPs) in the construction industry are rare.

The most frequently proposed reasons for these failures are the failure of noise-exposed individuals to make use of the HPDs for the duration of their exposure to noise. The reasons for this behaviour have been the subject of much research inside and outside the mining industry, but not specifically in underground gold miners in South Africa.

2.3 Magnitude of the Problem

NIHL has serious and widespread consequences to the individual, their co-workers, friends, family and society at large. In addition to the personal disability and decline in interpersonal interaction that occurs in people with NIHL (Crandell et. al 2004) and the economic costs of treating, rehabilitating and compensating sufferers, it has also been demonstrated that workplace safety decreases as a function of increasing noise levels and hearing loss across all age groups of workers (Schmidt, Royster & Pearson 1980). In 1994 R 274 million was paid to South African mineworkers for NIHL by the Compensation Commissioner (Zinsser 1999).

Whilst the exact incidence and prevalence of NIHL amongst underground gold miners in South Africa is not known, NIHL is widely recognised as being prevalent both locally and internationally.

Internationally, hearing loss in the general population is reported to be very common, with Murray-Johnson, Witte, Patel, Orrego, Zuckerman, Maxfield &

Thimons (2004) reporting that 90% of the American population reports a hearing deficit by the age of 55.

Workplace exposure to harmful noise, internationally, is also considered to be prevalent with NIHL considered a major health hazard in industry. This continued high prevalence of NIHL is supported by Lusk & Keleman (1993), who reported NIHL as one of the United States National Institute for Occupational Safety and Hygiene (NIOSH's) top 10 occupational hazards. The magnitude of this problem is further emphasised by Lusk, Ronis, Kazanis, Eakin, Hong & Raymond (2003) who estimated that 30 million American workers are exposed to harmful noise at work, and by Crandell, Mills & Gauthier (2004) who estimated that 40 million Americans are exposed to potentially harmful noise levels at work and that over 11 million exhibit some degree of permanent NIHL. Further proof of the significance of this problem is to be found in a report by Murray-Johnson, et al (2004) who reported that occupational NIHL is the second most self-reported occupational illness or injury in the United States.

Outside of the United States it is also generally accepted that NIHL is a common workplace problem worldwide. For example; Leinster, Baum, Tong & Whitehead (1994) reported that about 17 million people in the United Kingdom were exposed to noise levels of 85 dB (A) or more in their normal work. In New Zealand, McBride (2004) confirmed that noise exposure is prevalent in mining whilst the prevalence of NIHL amongst noise-exposed Malaysian factory workers is estimated at 30% (Maisarah & Said 1993).

Despite the lack of comparable statistics relating to potentially harmful noise exposure in the general population or in industry locally, research by Franz et. al. (1997) has indicated that the eight-hour time weighted average (TWA) exposure for miners is generally between 90 and 100 dB, whilst operators of certain production machinery were found to be exposed to ranges of between 95 and 110 dB. Such exposure levels are well into the potentially harmful range. Subsequently, it has been estimated that between 68% and 80% of mineworkers are exposed to a TWA of 85 dB or more, highlighting the magnitude of potential harmful exposure amongst South African miners. Since gold miners are subject to conditions similar to mineworkers in other commodities, and largely use similar equipment, it is assumed that these exposures are applicable to them as well.

2.4 Reasons for Failure of Hearing Conservation Programmes

It has been estimated that as many as 50% of HCPs fail within two years of being introduced (Kielblock 1999). Some of the cited reasons for this high failure rate include lack of managerial commitment, lack of choice of HPDs and a failure of conceptualisation of the negative social and health consequences of NIHL amongst exposed workers (Kielblock 1999). Leinster et al (1994) also cite management attributes and a lack of recognition of the noise hazard as further reasons for the failure of HCPs, whilst Lusk & Keleman (1993) and Crandell, Mills & Gauthier (2004) refer to the reasons for behavioural change extending beyond management stance or individual awareness to a theoretical framework of individual belief systems. These theories can broadly be divided into two separate theories: the health beliefs model, and the stages of change model. These theories suggest perceived vulnerability to and risk of negative health consequences and personal readiness to change as the overriding factors determining health-seeking behavioural change in general, and indirect predictors of use of HPDs in particular.

In any event, failure of any element of an HCP may result in the failure of the HCP as a whole. For this reason, all of these need to be investigated when determining the reasons for the persistence of NIHL. The elements of an HCP include the following:

- Awareness of the ability of noise to cause damage to hearing;
- Education as to the preventability of NIHL;
- Instruction on the correct method and habit of use of the devices; and
- Testing for the correctness of use.

In effect, these components include uptake and correct usage of the devices and knowledge, attitudes and practices relating to NIHL and the use of HPDs.

2.5 Uptake of Usage of Hearing Protection Devices

In the only study with specific data regarding the use of HPDs in South African miners that could be found, the *reported* usage was almost 75% (Kahan & Ross 1994). However, this study was conducted amongst a group of diamond miners who are traditionally different in cultural and social background to gold miners, the latter being mainly migrant workers from rural parts of South Africa and the former comprising predominantly local people from the communities surrounding the specific mines. Furthermore, no data regarding *actual or observed* usage was compiled in the Kahan & Ross (1994) study to compare to the reported usage. Also, this research was done prior to the promulgation of the MHSA in 1996, which constituted a watershed in terms of legislation and practice relating to noise control and HCPs in the mining industry.

Internationally, literature abounds for noise-exposed workers. Estimates of the use of HPDs in noise-exposed individuals vary substantially between studies, but are generally very low. Maisarah & Said (1993) reported the lowest uptake of about 5% in Malaysian factory workers despite HPDs being provided to over 80% of them, whilst Axelsson, et al (1978) found that one third of workers did not use ear protectors. Other studies also confirm low rates of HPD usage in noise-exposed workers. These include Landen, Wilkins, Stephenson & McWilliams (2004), who found that 48% of subjects reported that they never used hearing protection and Neitzal & Seixas (2005), who found self-reported usage less than one quarter of the time and that workers who reported always using HPDs in high noise zones were found to only wear them one third of the time. Other evidence of low usage was reported by Morata, Nylen, Krieg & Johnson (2004) who found that amongst Swedish workers lower percentages of workers always used when they were noise-exposed; Lusk et al (2003) who reported that workers do not always use HPDs when required; and Morata (2001), who found that 64% of workers indicated that they wore HPDs but only 20% of that subgroup stated that they wore the HPDs all the time they were exposed to noise.

Furthermore, in a study by Morata et al (2001), 79% of printing workers interviewed in Brazil said that they wore HPDs but only 20% said that they wore HPDs all the time when exposed to high noise levels.

2.6 Knowledge Regarding Noise Induced Hearing Loss and Hearing Protection Device usage

The level of knowledge of exposure to excessive noise as a cause of adverse health outcomes has been the topic of much research with respect to people with recreational noise exposure as well as exposure in the workplace.

With regard to occupational noise-exposure, a study by Lusk & Keleman (1993) reported that 98% of noise-exposed skilled tradesmen interviewed in a study in the construction industry indicated that they knew they were supposed to use HPDs. This finding is supported by Patel, Zuckerman, Murray-Johnson, Orrego, Maxfield, Meadows-Hogan, Tisdale & Thimons (2001), who reported high levels of knowledge, strong perceived severity of negative consequences, and strong perceived susceptibility to hearing loss amongst coal miners in the Appalachian Mountains.

With regard to recreational noise exposure, Crandell, Mills & Gauthier (2004) found that the majority of young adults interviewed in their study demonstrated a high degree of knowledge concerning factors associated with exposure to excessive noise and the risk of hearing loss.

However, Bogoch, House & Kudla (2005) found that only 34% of rock concert goers they interviewed thought that it was somewhat likely and almost 40% thought it was very likely that noise levels at music concerts could damage their hearing, but just over 80% said that they never wore hearing protection at such events.

Whilst the aforementioned literature suggests reasonably good knowledge of the adverse health outcomes of excessive noise exposure amongst recreational-and-occupational-noise-exposed individuals, evidence suggesting the contrary could also be found in the literature. For example, Leinster, Baum, Tong & Whitehead (1994) found in a large study on the attitudes towards noise in 48 organisations across Britain, that much of the time neither managers nor the workforce are conscious of the noise hazard. This suggestion of poor knowledge regarding the noise hazard in exposed individuals is supported in a study to ascertain the reasons for using HPDs amongst noise-exposed workers (Cheung 2004).

In this study, Cheung (2004) found that organisational regulation of occupational noise protection was the root cause of workers' protective behaviour, whereas workers' knowledge about the protection exhibited only a minimal effect. This finding is supported by the findings of Crandell et. al. (2004), who found that even in those with reported good knowledge of the adverse health outcomes of excessive noise exposure, the young adults interviewed revealed significant racial / ethnic differences in knowledge, behaviours, and attitudes about the use of HPDs.

These findings highlight the fact that knowledge of the adverse heath effects of noise alone is not sufficient to prompt behavioural change in the form of usage of HPDs at times of perceived vulnerability to NIHL, and suggests that even when knowledge of the noise hazard exists, it is not necessarily the driving force in determining behaviour with respect to use of HPDs.

As regards South African miners specifically, Kielblock & Van Rensburg (1988) found that 80% of respondents did not consider noise to be a "problem" in their jobs, whilst Kahan & Ross (1994) also found that South African mineworkers were poorly informed regarding the fact that noise was a health hazard, but that almost 77% felt that they worked in a noisy place.

There is contradictory evidence in the literature, therefore, with regard to the level of knowledge of the harmful effects of excessive noise exposure amongst recreational and occupational noise-exposed people in general. There is also evidence in the literature that South African miners had a low level of knowledge of the noise hazard and HPD usage in 1994. However, because much effort has been put into HCPs since then and knowledge alone of the noise hazard is insufficient to modify behaviour and HPD use, this study is certainly relevant in answering the study questions regarding knowledge and attitudes towards NIHL and HPDs and actual and reported use of HPDs in the specified study population at this point in time.

2.7 Attitudes towards Noise Induced Hearing Loss and Hearing Protection Device Usage

The literature suggests non adherence to the use of HPDs in noise-exposed workers. For example, Svensson, Morata, Nylen, Krieg & Johnson (2004) found that 90% of the Swedish noise-exposed workers interviewed by them considered hearing loss to be a serious problem and 85% believed that HPDs could protect their hearing. However, lower percentages of workers reported always using HPDs when exposed to noise. Fifty five per cent said they could not hear warning signals when using HPDs and 45% considered HPDs uncomfortable. Also, Axelsson, Axelsson & Jonsson (1978) found a huge variation in the preferences of HPDs in Swedish factory workers. For example, plastic earplugs were preferred by 44%, vinyl foam earplugs by 26%, fibreglass by 18%, and ear-muffs by 11% of the workers. The range of preferences described by study participants highlights one of the practical difficulties in providing HPDs to noise-exposed individuals by companies who may not be able to provide a range that will suit all employees.

Furthermore, there is evidence in the literature suggesting differences in attitudes towards NIHL and HPD usage amongst different demographic sections of the population. Rabinowitz & Duran (2001) found amongst Hispanic workers exposed to occupational noise that less acculturated workers underutilise HPDs in the workplace due to *perceived* barriers to use of HPDs.

Widen & Erlandsson (2004) found that adolescents' attitudes and behaviours regarding hearing protection use differed between socioeconomic levels.

Lusk, Kerr & Kauffman (1998) found that in the relationship between HPD use and trade category, education, age, years of employment, and trade group amongst construction workers that only trade group exhibited significant differences, whilst Crandell, Mills & Gauthier (2004) reported that educational programmes are more beneficial when developed for specific age and / ethnic / racial groups. These findings are relevant to this study population, who comprise workers from various different backgrounds, cultural, trade, and ethnic groups.

With respect to South Africa, Kahan & Ross (1994) found that the main reasons for not using HPDs was a lack of knowledge, discomfort of HPDs, and insecurity

as a result of the perceived inhibition of communication and the inability to hear warning signals.

It is evident, therefore, that attitudes to NIHL and the use of HPDs internationally, vary between individuals with possible differences between attitudes of different age, racial and ethnic groups.

2.8 Reasons for not Using Hearing Protection Devices

As alluded to earlier, factors contributing to the failure of noise-exposed individuals to use HPDs have been divided into individual and environmental categories (Patel, Zuckerman, Murray-Johnson, Orrego, Maxfield, Meadows-Hogan, Tisdale & Thimons, (2001). Individual factors include lack of knowledge that one's own working environment poses a health risk and preference for different types of HPDs. This finding was supported in a South African survey of mine workers (Kahan & Ross 1994) as well as in a survey of Swedish workers (Axelsson et al 1978). McCullagh, Lusk & Ronis (2002) identified in a logistical regression analysis other individual factors. These included interpersonal support barriers and situational influences as statistically significant predictors of this health behaviour, correctly predicting 78% of cases amongst farmers in the US.

Even where the perceived knowledge of noise as a hazard was found to be good, there are still failures of HCPs, for different reasons. Lusk & Keleman (1993), for example, report 98% of skilled tradesmen indicated that they were supposed to use HPDs yet their reported use averaged around 50% of the time. Reported use significantly and positively correlated with workers' perceptions of the benefits and self-efficacy of use, value of outcomes regarding keeping out noise and increased well being, and health-promoting behaviours in the areas of self actualisation and stress management.

In terms of environmental factors, Morata, Fiorini, Fischer, Krieg, Gozzoli & Colacioppo (2001) found in printing workers in Brazil that reasons for not using HPDs when they were exposed to noise included interference with communication, interference with job performance, comfort issues, and self-perception of hearing condition. These findings were supported by Morata

(2001), who found that reasons offered by workers for not using HPDs included interference with communication, interference with job performance, comfort issues, self perception of hearing condition and inability to detect warning signals. Finally, in South Africa, similar reasons for not using HPDs were found in a study by Kielblock & Van Rensburg (1988), who found that that 47% of those interviewed thought that using HPDs would interfere with their communication and hearing of warning signals. Kahan & Ross (1994), also found that reported reasons for non use of HPDs included discomfort of use, perceived inability to communicate effectively whilst using HPDs, and the perceived inability to hear warning signals.

The perception that HPDs interfere with communication and the ability to hear warning signals has been proven to be untrue by research done by Plyler & Klumpp (2003), who found that communication ability in noise was not significantly impacted by varying the signal presentation level when utilising HPDs. However, this misconception is likely to be contributing to the failure of usage of HPDs and consequently HCPs and, if workers perceive this to be the case with them, education may prove to clear this misconception. Furthermore, it has also been reported that less acculturated workers may be underutilising HPDs due to perceived barriers to their use, and that HCPs in workplaces with a high proportion of immigrant workers need to address language and cultural barriers to the use of HPDs in order to be more successful (Rabinowitz & Duran 2001). This fact is also relevant to this study, since the study population comprises a high proportion of migrant workers with different languages and cultures. The literature suggests that this diversity may serve as a barrier to the effectiveness of current HCPs.

2.9 Justification for the Study

Since elimination, substitution, engineering and administrative controls are at present ineffective in minimising noise dose to workers in many industries, there is a worldwide reliance on PPE as part of HCPs in many industries, including gold mining. Determining the use of HPDs in underground gold miners, therefore, would provide valuable insight into the effectiveness of HCPs; determining the knowledge, attitudes and practices of underground gold miners relating to NIHL and HPDs allows for a better understanding of the drivers of such use. This knowledge would facilitate informed recommendations for intervention strategies aimed at improving HCPs, thereby preserving hearing and preventing NIHL in noise-exposed individuals. Despite the aforementioned documented reasons for non-usage of HPDs in underground mine workers in South Africa, no study could be found that had investigated these factors after the introduction of HCPs as per the Mine Health and Safety Act (1996). For this reason, it is questionable whether the aforementioned factors are still true and relevant to this group of workers or whether other factors are resulting in the failure of HCPs.

Furthermore, no recent studies have been undertaken to assess any possible changes in these knowledge levels, attitudes towards HPD usage or actual use of HPDs in South African miners. Therefore the findings of this study will be used to inform new strategies to reduce the burden of this preventable condition. The study also aims to compare actual and reported use of HPDs, which may provide valuable insight into the practical issues surrounding HPD usage as well as the underlying attitudes to NIHL and HPDs.

3 METHODOLOGY

3.1 Study Site Description

The study was carried out at an underground gold mine approximately 60km West of Johannesburg which employs about 14 500 people at its underground and surface operations in the area. The mine comprises several shafts where mining occurs. Surrounding hostels accommodate approximately 70% of the employees. The remaining employees reside in the surrounding areas.

3.2 Study Population

Not all the workforce at this mine was exposed to excessive noise at work. The non-noise-exposed miners were omitted as they were not eligible for inclusion in the study. In miners in general, it has been estimated by the United States National Institute for Occupational Safety and Health (NIOSH) in 2003 that 85% of miners work in an environment with noise levels in excess of 85 dB (A). This estimated proportion of noise-exposed miners was applied to this study population and hence the study population comprised only 85% of the total workforce on the mine; i.e. approximately 12 325.

3.3 Study Sample

A list of the occupations considered to be ‘noisy’ (noise exposure greater than or equal to 85 dB (A)) was obtained from the occupational hygiene department at the mine. Workplaces containing such workers were then identified and selected randomly from a complete list of workplaces, for inclusion in the study. This was done by random number generation using Microsoft Excel®. All employees in the selected workplaces were then approached to participate in the study. Recruiting of participants was continued until 101 questionnaires were returned and the required sample size had been achieved. Only 1 person refused to participate in the study and so the response rate was 99% (101 / 200 X 100).

3.4 Sample Size Calculation:

The sample size was calculated using Epi Info ® Version 3.3.2 with the following parameters:

- Assumed population of exposed workers 14 500;
- Assumed prevalence of HPD non-usage = 50%;
- Worst acceptable frequency = 40%; and
- Assumed margin of error = 10%.

The calculation yielded a sample size of 95.

An additional 5% (ie 5) was added in case of withdrawals or spoilt responses, bringing the sample size to 100. One hundred and one questionnaires were completed.

3.5 Measurement

3.5.1 Study design

A cross-sectional descriptive study design was employed since the study set out to determine the prevalence of actual and reported usage of HPDs and related knowledge, attitudes and practices at an instant in time, at a particular study site.

3.5.2 Variables measured

The following variables were measured in this study:

3.5.2.1 Knowledge, attitudes & practices relating to NIHL and HPD usage

Face-to-face structured interviews were carried out with the help of an interview schedule (Appendix A). These were administered by members of the Occupational Hygiene department at the mine who were fluent in the relevant local languages to improve interpretation of the miners' knowledge, attitude and practices as regards NIHL and HPD usage. The interviewers carefully explained the reasons for the study as well as the method of conducting the study to all participants (Appendix B). The interviews were anonymous and unlinked and

written informed consent was obtained prior to all interviews and observations of the usage of HPDs (Appendix C). Persons who refused to participate were not prejudiced in any way. Questionnaires were administered privately in the workplaces of participants but away from major noise sources.

3.5.2.2 Use of hearing protection devices

HPDs are readily and easily visible from a reasonable distance during conversation. Observation of the use of HPDs was made prior to the administration of questionnaires but only recorded after successful informed consent was given by participants.

3.5.3 Data collection techniques

The HPD usage and interview process was carried out in the employees' workplaces away from the main noise sources such as rock drills and ventilation fans. Results were anonymous and unlinked and kept confidential. Written informed consent was obtained before the interviews and observation for HPD usage. Data was captured on Microsoft Excel® version XP. Quality and consistency were aimed for through keeping the questions simple and mainly closed ended. Accuracy was expected in terms of the responses as a result of careful explanation of the importance of the study as well as the facts that results were anonymous, unlinked and confidential.

3.5.4 Data collation

One hundred and one completed questionnaires were returned and hence the reported results total 101 except where questions were not applicable, were left blank by the respondent, or where multiple responses were allowed. The first of these resulted in a lower number of total responses whilst the last resulted in a higher total. Such instances are highlighted where applicable. A significance level of 10% (Alpha = 0.1) was selected as the cut off for statistical significance owing to the descriptive nature of the study, as well as the intention to identify associations between variables rather than proving causality.

4 ASSUMPTIONS

The following assumptions relate to the research questions:

- Measured usage of hearing protection devices (HPDs) amongst the study sample is representative of general usage of HPDs amongst the entire study population;
- HPD usage remains relatively constant over the year i.e. there is no seasonal variation; and
- Responses to the interviews honestly reflect prevailing knowledge, attitudes and practices relating to the use of HPDs.

5 POSSIBLE LIMITATIONS

The research aimed to assess the actual usage of Hearing Protection Devices (HPDs) in the workplace and the related knowledge, attitudes and practices of exposed persons in order to inform strategies to prevent further cases of noise induced hearing loss (NIHL) in the specified population.

- It did not address medical conditions or interventions which may influence hearing, nor any issues regarding the attenuation of noise at its source, through using less noisy machinery, implementing engineering controls to muffle sound emissions, or administrative controls such as shorter shifts to reduce noise exposure dosage. These interventions were considered to be beyond the scope of this research report.
- The numerous languages spoken by underground gold miners in the study population and translation by interviewers were another possible limitation of this study since translation of the questionnaires could possibly have influenced understanding and interpretation of the questions.
- The use of HPDs and the knowledge, attitudes and practices of miners relating to social and recreational (non-occupational) noise exposure was not considered in this study as it is considered to be beyond the scope of this paper.
- Whilst the interviewers were Occupational Hygiene staff at the mine who in no way have line responsibility for participants, the possibility that participants could have felt compelled to report using HPDs is noted.
- The technical quality of HPDs (i.e. efficacy and efficiency) is not investigated or discussed as it is considered to be beyond the scope of this research study.

6 ETHICAL CONSIDERATIONS

- Written permission granting access to workplaces and miners was obtained. Opportunity was given for addressing any issues that arose from the study prior to commencement.
- Written informed consent was sought from selected participants prior to enrolment. Any person refusing to participate was excluded from the study and not prejudiced in any way. All information was treated confidentially. Only aggregate data is being reported on.
- No physical testing was done, and there was therefore no physical harm or interference. The results are being reported as group results.
- The study protocol was submitted to and approved by a postgraduate research panel at the University of the Witwatersrand.
- The study commenced only after written approval by the committee for research on human subjects (Medical) of the University of the Witwatersrand had been received (Protocol number M050914).

7 DATA PROCESSING AND DATA ANALYSIS

Data was processed and analysed using Microsoft Excel XP ® software for collation and NCSS ® for statistical analyses.

8 RESULTS AND ANALYSIS

The results of the study are now presented, analysed and discussed, beginning with actual and reported Hearing Protection Device (HPD) usage. The knowledge of participants is then inferred from their reported knowledge regarding noise as a hazard; the reported benefits of using HPDs; their perception of their work environment; and their reported knowledge of insertion, cleaning and storage of HPDs. The attitudes of respondents towards noise induced hearing loss (NIHL) and HPD usage is then determined from responses to questions on the importance of NIHL relative to other workplace illnesses and injuries, reasons given for using HPDs; preferences of respondents regarding who should educate them about NIHL and HPD usage; and what medium of education this should be. Factors affecting the use of HPDs such as access to HPDs, the availability of HPDs free of charge and the availability of more than one type of HPD are then discussed.

The section commences with an overview of the demographics of the respondents compared to the study population and concludes with an analysis of the reported reasons for not using HPDs.

Tables include numbers of responses which total 101, except where questions were not applicable or left blank by the participant, in which case the total is lower. Where more than one response was provided, the total number of responses exceeds 101.

8.1 Demographic Data

Table 1 Demographic Variables of Participants and Workforce

Demographic Data			
		Of study participants	Of mine workforce*
Place of Origin	Lesotho	18%	18%
	Mozambique	24%	15%
	Eastern Cape	20%	23%
	Gauteng	14%	13%
	North West	6%	2%
	Free State	2%	2%
	Botswana	4%	4%
	Other	12%	22%
	Total	**100%**	**100%**
Average Age		38	40
Average No of years in current Occupation		10	2
Average No of years in mining industry		14	10
Site of Work	Surface	1%	10%
	Underground	99%	90%
	Total	**99%**	**10%**
Type of employment	Full time	88%	82%
	Contractor	12%	18%
	Total	**100%**	**100%**

*Source: Human Resources Department at the mine

The places of origin, average ages, average number of years in mining and type of employment of respondents are very similar to those of the study population. Study participants are, therefore, considered similar in terms of demographic characteristics to the study population and therefore generally representative of the study population for the purposes of this research report. The noteworthy differences are a much greater number of years in mining for study participants compared with the mine workforce (ten compared with two) and that almost all respondents (99%) worked underground compared with 90% of all people employed at this mine. The former suggests that respondents are amongst the more experienced employees and may represent a less mobile portion of the general workforce at this mine. The latter is merely due to the fact that fewer people employed on surface are exposed to noise than those who work underground. These differences are addressed where they are considered relevant to the findings, analysis, discussion and recommendations presented.

8.2 Hearing Protection Device Usage

8.2.1 Reported versus observed use of hearing protection devices

The following categories relating to HPD usage were investigated:

- Reported self use
- Reported co-worker use
- Observed use

Reported self-and co-worker HPD usage comprised responses in the affirmative to direct questions on whether respondents used HPDs in the workplace and whether they thought their co-workers did so, respectively. Observed use represents the use of HPDs by the respondents as observed by the interviewers prior to interview. These findings were then recorded in each questionnaire of employees who consented to participate (Appendix A).

Whilst reported self-use and reported co-worker use of HPDS were similarly high, at 93% and 92% respectively, these differed substantially from the relatively low observed usage rate of 50%, as is illustrated in Table 2.

Table 2 Hearing Protection Device Usage

HPD use by miners						
	Reported self use		Reported Co-worker use		Observed Use	
	Number	%	Number	%	Number	%
Yes	94	93%	93	92%	50	50%
No	5	5%	6	6%	38	38%
Unkown/ illegible/ blank/ NA	2	2%	2	2%	13	13%
Total	**101**	**100%**	**101**	**100%**	**101**	**100%**

Whilst it may have been expected, from the literature review (Section 2.5), that more people would report using HPDs than actually did so there is a very large variance between the two results (93% vs. 50% respectively). These data clearly point to an under usage of HPDs in the study sample, which is likely to also be the case in the study population. This under usage of HPDs would result in overexposure of individuals to noise, resulting in NIHL and would explain the inconsistent success of existing HCPs.

Reasons for the aforementioned difference between reported and observed use of HPDs include:

- Fear of disciplinary action or fear of embarrassment. These are theoretical possibilities but their importance in this study should be considered in the following context:
    - The interviews were not conducted by line supervisors of the respondents;
    - The interviews were conducted privately on a one-on-one basis within the workplace rather than in groups, which could have increased embarrassment or resulted in peer pressure; and
    - No disciplinary procedure currently exists for non usage of HPDs in the workplace at the operation concerned.
- Respondents actually use HPDs when they perceive a noise hazard, but did not perceive such at the time of interview. This possibility is the likelier of the two that have been mentioned and will be discussed in greater detail in the later sections of this report.
- Respondents may have provided a response they perceived to be what the interviewer wanted to hear or was expecting to hear and did not reflect what they actually did in the workplace.

Notwithstanding the possible reasons for the discrepancy, the huge difference between reported and observed usage of HPDs amongst respondents in this study points to a disparity between reported and actual practice and suggests that the HCP at this study site is suboptimal and that embarrassment or the fear of being reported to a supervisor are potential reasons for the difference noted.

8.2.2 Consistency of use of hearing protection devices

Consistency of use of HPDs (the pattern of use of HPDs from day to day) is vitally important to their effectiveness in protecting the hearing of wearers, in that even short durations of exposure to noise at high intensities may result in NIHL in individuals who use HPDs frequently but not consistently. Table 3 (below) outlines reported consistency of use of HPDs.

Table 3 Reported Consistency of Hearing Protection Device Usage

Reported consistency of use of HPDs				
	Self use		Co-worker Use	
	Number	%	Number	%
All the time at work	25	24%	24	22%
Every day but only when there is a lot of noise at work	44	42%	47	43%
Most days when there is a lot of noise at work	11	10%	8	7%
Some days when there is a lot of noise at work	21	20%	27	25%
Never	0	0%	1	1%
Illegible/ blank/ N/A	4	4%	3	3%
Total*	**105**	**100%**	**110**	**100%**

* Some respondents offered more than one response

When asked about the consistency of self-use of HPDs, 66% of respondents reported consistent usage (all the time at work - 24%; and every day when there is a lot of noise at work - 42%). However, a surprisingly high proportion (30%) reported inconsistent use of HPDs (on some days or most days when there was a lot of noise at work – 20% and 10% respectively).

This 30% who admitted inconsistent use of HPDs reflect a proportion of respondents who would consequently be at increased risk of developing NIHL.

When asked about the consistency of use of HPDs of their co-workers, the majority of respondents (65%) reported that their co-workers used them daily when exposed to noise or all the time at work. Only 25% of respondents reported that their co-workers only used HPDs some days when there was a lot of noise at work. Even though these responses suggest that the perception of respondents was that the majority of their co-workers used HPDs in an inconsistent fashion, they also suggest that most respondents considered their co-workers to use HPDs more often than not.

8.2.3 Continuity of use of hearing protection devices

Just as consistency of use of HPDs is important in protecting the hearing of individuals using HPDs, so too is continuity of use (use of the devices over the shift). Continuity of HPD usage is important since there are multiple sources of noise exposure in mining workplaces and the noise hazard does not cease when the person stops using equipment he or she perceives to be responsible for his or her exposure. For this reason it is important that for individuals to be adequately protected from hazardous noise exposure in the workplace they use

HPDs to attenuate noise from noise sources they perceive to be hazardous to their hearing, as well as those they do not perceive to be so but which also may constitute hazardous noise.

Whilst 31% of respondents claimed to always use HPDs for the entire shift, the vast majority (58%) reported only doing so sometimes and 9% claimed never to do so, thus underlining the vulnerability of these people to noise damage when not protected by HPDs (Table 4).

Table 4 Reported Continuity of Hearing Protection Device Usage

Reported continuity of self use of HPDs		
	Number	**%**
Always use HPDs for the whole shift	31	31%
Sometimes use HPDs for the whole shift	59	58%
Never use HPDs for the whole shift	9	9%
Illegible/ blank/ N/A	2	2%
Total	**101**	**100%**

8.2.4 Summary of findings relating to the use of hearing protection devices

In summary, whilst 93% of study participants reported that they used HPDs at work and 92% reported that their co-workers did so, only 50% of participants were actually observed using HPDs in their workplaces prior to the interviews being conducted. This was the finding despite the fact that the reported workplace noise exposure of all participants necessitated the use of HPDs. Furthermore, a large proportion of respondents reported using HPDs inconsistently and not continuously at work, all of which makes them susceptible to developing NIHL.

8.3 Knowledge of Respondents

Determining the level of knowledge regarding NIHL and HPD usage amongst miners allows for a better understanding of the reasons for use and non-use of these devices and therefore provides meaningful insight into the drivers of this behaviour. This knowledge also allows for a greater appreciation of the issues around NIHL in this environment as well as informing recommendations to address these.

Data demonstrating knowledge of respondents are now presented and discussed with reference to knowledge of noise as a workplace hazard, knowledge of the benefits of HPDs (respondents' own knowledge and reported knowledge of co-workers), respondents' reported perception of their work environment, and knowledge of correct insertion, cleaning and storage of HPDs.

8.3.1 Knowledge of noise as a hazard

Whilst the vast majority of responses (82%) indicated that respondents knew that noisy work had the potential to affect hearing, a high proportion (17%) indicated that they did not, 11% of these believing it did not and 6% stating that they were unsure. (See Table 5).

These data illustrate a low level of knowledge of noise as a hazard (at just 82%), since all employees at this operation are meant to be educated about this fact at induction, and then during refresher training (at least annually) upon returning from leave, as per the standard procedures of the mine's hearing conservation programme. The implication is that about 2 610 (18% of the total of approximately 14 500) employees at this mine are unaware of the potential of excessive noise exposure at work to damage hearing.

Table 5 Reported Knowledge of Noise as a Hazard

Knowledge of the potential of noisy work to damage hearing		
	Number	**%**
Yes	83	82%
No	11	11%
Don't know	6	6%
Illegible/ blank/ N/A	1	1%
Total	**101**	**100%**

This relatively high proportion of respondents who indicated a lack of knowledge of noise as a hazard is also surprising in view of the high proportion of participants who indicated that they use HPDs (Table 1). This finding also indicates that despite the apparent knowledge that HPDs are necessary at work, knowledge of workplace noise as a health hazard is poor.

8.3.2 Knowledge of the benefits of using hearing protection devices

The finding that knowledge of noise as a workplace hazard is poor, despite apparent knowledge of the necessity to use HPDs at work, is supported by data obtained from the responses to questions in the interview on reported perception of respondents regarding their own knowledge as well as that of their co-workers about HPDs. These data are demonstrated in Table 6 below.

Table 6 Perception of the Benefits of Using Hearing Protection Devices

Reported Perception of Benefits of Using HPDs				
	Perception of benefit reported for self		Perception of benefit for co-workers	
	Number	%	Number	%
Beneficial	90	89%	84	83%
Not beneficial	3	3%	2	2%
Don't know	6	6%	13	13%
Illegible/ blank/ N/A	2	2%	2	2%
Total	**101**	**100%**	**101**	**100%**

Whilst the rates of people who reported that HPDs were beneficial (89%) and that they believed their co-workers to share this view (83%) may seem high, the remainder of respondents themselves either did not know that HPDs are beneficial (6%) or erroneously believed that they were not beneficial (3%). Furthermore, 13% of respondents indicated that their co-workers did not know whether HPDs were beneficial and 2% indicated that their colleagues believed the contrary, ie that HPDs were not beneficial. Once again this finding was surprising considering that all employees were supposedly educated about the benefits of using HPDs at work, at induction, and at least annually thereafter as part of refresher training as stipulated in the mine's HCP.

All of the respondents who believed HPDs not to be beneficial in a noisy environment as well as those unsure of the benefit of HPD usage in such noisy work environments are at increased risk of developing NIHL

This lack of understanding of the benefits of HPD usage in exposed individuals is further supported by the following data (given in Table 7) which shows that despite all the interventions stipulated in the HCP, 8% of respondents indicated that they were never informed about the benefits of HPD usage.

Table 7 Explanation of the Benefits of Hearing Protection Devices

Ever Explained the Benefits of HPDs?		
	Number	**%**
Yes	88	87%
No	8	8%
Illegible / blank / N/A	5	5%
Total	**101**	**100%**

This finding may be as a result of:

- Employees not receiving the prescribed training;
- Employees not understanding or assimilating the content of the training;
- Employees forgetting the training content; and / or
- Deficiencies in the training programme with regard to the education around the benefits of using HPDs.

Because of the requirement for completed training as a prerequisite to proceed to work and the strict adherence to this policy for legal and other reasons in South African mines as well as the formalised system of assessing the training outcomes of each employee at each visit, it is unlikely that the first point above is the main reason for this finding. It is far more likely that the latter three reasons may be responsible for this reported lack of knowledge of the benefit of HPD usage. Hence the training programmes may be inadequate or inappropriate for these individuals or these individuals may forget the training material content.

Whilst these findings are important, they are all the more surprising when considered in conjunction with the fact that the average number of years in the particular occupation of respondents is 10 years and that the average duration of employment of respondents in the mining industry is 14 years. Hence, not only has there been a failure to educate employees about the benefits of HPDs but this failure has occurred despite the supposed frequency of visits by respondents to the centres where this education is meant to have taken place. Considering that the average length of service and number of years in the mining industry is higher for study participants than for the study population, there may be an even greater lack of knowledge amongst the study population since they should have had fewer education and training sessions over their fewer years of service and employ in the mining industry.

These findings are supported by data in Table 8, below, which shows that despite these intensive initial and subsequent training at induction and annual refresher courses, only 52% of responses indicated that respondents were explained the benefits of HPD usage at induction. The remaining responses indicated training by others, who are not formally part of the HCP, except for the Occupational Health Centre staff.

Table 8 Who Explained the Benefits of Hearing Protection Devices

Whom have you been explained the benefits of HPDs by?		
	Number	**%**
Induction (including annual refreshers)	78	52%
Supervisor	28	19%
Coworkers	21	14%
Medical staff at a hospital or clinic	6	4%
Occupational Health staff	7	5%
Other	8	5%
Illegible/ blank/ N/A	2	1%
Total*	**150**	**100%**

* Some respondents offered more than one response

It seems that despite the rigorous interventions at this mine to train people on the benefits of HPD usage, the responses indicate that the current primary training process has not succeeded in doing so in almost half of respondents.

8.3.3 Perception of work environment

All participants in the study worked in environments with time-weighted-average noise-exposure levels above 85 dB (A). For the purpose of this report, these levels are considered 'noisy'. Yet a surprisingly high proportion of respondents (13%) perceived their work environment as not being noisy (Table 9). Two respondents (2%) indicated that they did not know whether they worked in noisy environments or not.

Table 9 Perception of Work Environment

Perception of work environment		
	Number	**%**
Work environment perceived as noisy	85	84%
Work environment perceived as not being noisy	13	13%
Don't know	2	2%
Illegible/ blank/ N/A	1	1%
Total	**101**	**100%**

Those who perceived their work environments as not being noisy, when in fact they were, represent another group of individuals at increased risk of developing NIHL due to the incorrect perception of their risk exposure and consequent likely failure to use HPDs when they should, despite their possibly knowing the benefits of these.

This misconception of the noise hazard in the work environment may be a significant cause of failure to use HPDs. Importantly, the correct perception of the workplace as noisy is statistically significantly correlated with the reported self-use of HPDs (Table 10, below).

Table 10 Cross-tabulation Report of Perception of Work Environment versus Reported Self-use of Hearing Protection Devices

		Perception of work environment as noisy		
		Yes	**No**	**Total**
Reported Self Use of HPDs	**Yes**	82	10	92
	No	2	3	5
	Total	84	13	97
Probability Level = 0.002				

This finding highlights a need to correct the misconceptions around the perceived workplace exposure in order to increase the appropriate use of HPDs. Since education regarding NIHL and the use of HPDs was not statistically significantly correlated with perception of the noise hazard, it is not general education about NIHL that is required but rather education around the noise levels in the workplace that needs to be conveyed to susceptible individuals.

The above analysis demonstrates that miners indicated that they used HPDs when they were aware of their work environments as being noisy. Those respondents who correctly considered their work environments as noisy and indicated that they used HPDs were not statistically significantly correlated with observed use. This finding further supports the suggestion that those not using HPDs at the time of interview but indicating that they used HPDs when exposed to noise, did so because of a lack of recognition of the noise hazard in their work environments.

Whilst demarcation of noisy workplaces was not the subject of this research, it would be worthwhile assessing the quality and quantity of such demarcation signage, since such signage is meant to highlight that a workplace is noisy to all entering it.

8.3.4 Knowledge of insertion, cleaning and storage of hearing protection devices

Further insights into the knowledge of participants regarding HPDs can be assessed from their responses to questions around insertion, cleaning and storage of these devices (Table 11). These insights are important not only to ascertain correct practices but also since failure to correctly insert, clean or store HPDs renders them less effective or even useless in attenuating noise and protecting hearing, even if they are used regularly and frequently. Therefore, good knowledge of these processes has the potential to increase the effectiveness of HCPs, whereas lack of knowledge of these practices has the opposite effect.

Table 11 Reported Knowledge of Hearing Protection Device Insertion, Cleaning and Storage

Reported knowledge of HPD Insertion, Cleaning & Storage						
	Insertion		Cleaning		Storage	
	Number	%	Number	%	Number	%
Yes	82	81%	47	47%	60	59%
No	18	18%	53	52%	40	40%
Illegible/ blank/ N/A	1	1%	1	1%	1	1%
Total	**101**	**100%**	**101**	**100%**	**101**	**100%**

Whilst knowledge of the cleaning and storage of these devices is not a necessity for users owing to the mine using devices which may be disposed of after a single use, it is still concerning to note the overall indication of a lack of education in this regard as some workers may in fact be using them more than once, especially on the same day. Furthermore, the finding that 18% of respondents were apparently not trained on the insertion of HPDs is noteworthy since the technique of insertion has a direct bearing on the effectiveness and noise-attenuation ability of these devices and, consequently, their effectiveness in preventing hearing loss. The intention of this question was not to assess the correctness of the knowledge on insertion, cleaning and storage but merely to ascertain whether participants were ever educated about these. Hence those who responded in the affirmative cannot be assumed to have any knowledge of these facts, making the knowledge gap potentially even greater than reported.

8.3.5 Summary of findings relating to reported knowledge of NIHL and the use of hearing protection devices

In summary the data suggest that knowledge of noise as a workplace hazard (i.e. potential of noisy work to damage hearing), knowledge of the benefits of using HPDs, knowledge of their workplaces being noisy and knowledge of correct insertion, cleaning and storage of HPDs is deficient amongst a significant minority of respondents to an extent that places them at risk of developing NIHL. Additionally, reports that a significant proportion of participants claimed never to have been educated about HPDs or not educated at induction (when the study site's procedures indicate that this should have been the case) points to problems with the reported outcomes of the education and training around noise exposure, NIHL and HPDs.

8.4 Attitudes towards Noise Induced Hearing Loss and the Use of Hearing Protection Devices

The reported attitudes of miners towards NIHL and the use of HPDs is discussed in terms of the relative importance of NIHL compared with workplace injuries and diseases, who is responsible for miners' hearing, reasons for co-workers using HPDs, and reasons for respondents' own use of HPDs. This discussion is then followed by a report and discussion on whether miners believe anything can be done to influence the use of HPDs, what medium they would prefer for instruction in the use of HPDs, and who they would prefer to conduct the instruction.

8.4.1 Relative importance of noise induced hearing loss compared with other workplace injuries and illnesses

The data in Table 12 (below) suggest that most participants consider NIHL to be very important as evidenced by the fact that when asked about the importance of NIHL relative to other workplace issues such as illnesses and injuries, the majority of respondents (68%) reported that all of these were equally important with 18% considering NIHL more important than other workplace injuries and illnesses and only 9% considering it less so.

Table 12 Reported Relative Importance of NIHL

Reported knowledge of HPD Insertion, Cleaning & Storage						
	Insertion		Cleaning		Storage	
	Number	%	Number	%	Number	%
Yes	82	81%	47	47%	60	59%
No	18	18%	53	52%	40	40%
Illegible/ blank/ N/A	1	1%	1	1%	1	1%
Total	**101**	**100%**	**101**	**100%**	**101**	**100%**

The combined total proportion of responses (86%) who indicated that NIHL is equally or more important than workplace injuries and illnesses suggests a recognition of NIHL as a serious health issue amongst respondents. This finding contradicts the anecdotal suggestion that due to the relatively higher visibility and greater immediacy of workplace injuries and certain occupational diseases (such

as Tuberculosis, for example) NIHL may be considered less important by gold miners than these other health hazards. These findings have to be viewed, of course, against the possible emphasis on NIHL introduced by the study itself, which may have biased responses to this question in favour of NIHL.

This reported relative importance of NIHL in the opinion of respondents supports the high reported rate of usage of HPDs in the workplace, but apparently contradicts the low observed usage of 50% (Table 2). This reported relative importance of NIHL also points to reasons other than perceived importance of this condition as a cause of failure to use HPDs when necessary, which is discussed in further detail in subsequent sections of this report.

8.4.2 Responsibility for noise induced hearing loss

From the responses to a question on whose responsibility miners' hearing is (Table 13), it is evident the vast majority of respondents (92%) consider miners themselves to be responsible for their hearing, with only 1% considering hearing as management's responsibility.

Table 13 Reported Responsibility for Miners' Hearing

Reported responsibility for taking care of miners' hearing		
	Number	**%**
Miners themselves	93	92%
Management	1	1%
Other	2	2%
Illegible/ blank/ N/A	5	5%
Total	**101**	**100%**

This strong indicated perception amongst respondents that miners are themselves responsible for their hearing points to an internal locus of control and suggests generally good insight into this particular issue. This good insight, coupled with the high relative importance of NIHL amongst respondents (Table 12), suggests that the attitudes of miners interviewed towards NIHL, is one of assumption of responsibility. This finding also suggests that the low observed usage figure of 50% of respondents (Table 2) is probably not due to an abdication of responsibility for this condition but rather other factors, discussed in Section 9 of this report.

8.4.3 Reasons for using hearing protection devices

Table 14 Reported Perceived Benefits of Using Hearing Protection Devices

Reported Perceived Benefits of Using HPDs				
	Self		By co-workers	
	Number	%	Number	%
Reduces noise, protects hearing safety and health	78	77%	68	67%
Told to do so	1	1%	4	4%
Illegible/ blank/ N/A	22	22%	29	29%
Total	**101**	**100%**	**101**	**100%**

With regard to reported reasons for self-use of HPDs amongst respondents, 77% of responses indicated that respondents knew that HPDs reduced noise, protected hearing, and were important for safety and health (Table 14).

The low proportion of respondents (1%) in this category citing that they would use HPDs because they were told to do so supports the arguments opposing coercion and positive reinforcement as reasons for HPD use in this study.

With regard to reported reasons for co-workers using HPDs, the above data suggest that the majority of participants (67%) reported that their co-workers used HPDs for noise reduction, hearing protection or health and safety reasons. This finding suggests good insight into the reasons for using HPDs. Only 4% of respondents indicated that their co-workers used HPDs because they were instructed to do so.

These data indicate a good level of knowledge of the benefits of HPD usage whilst also suggesting that generally a culture of coercion does not drive the use of HPDs. However, the data may conversely suggest that the few responses identifying instructions to use HPDs as a reason to do so may be indicative of a lack of positive reinforcement around HPD usage both from supervisors as well as co-workers. Whilst the actual drivers for the stated responses cannot be established by this research, the reasons cited suggest that a lack of knowledge of the benefits of HPD usage is unlikely to be a reason for non-usage. The group of responses comprising Illegible, blank or N/A may represent respondents who were uncertain of the benefits or did not know of any.

Despite the inference from the above data of generally good insight into NIHL and HPD usage and a generally positive attitude, these are unfortunately not associated with the desired behavioural outcomes in terms of HPD usage, as evidenced by the aforementioned low observed usage of 50% (Table 2).

8.4.4 Influencing the use of hearing protection devices

When asked whether they felt that anything could be done to influence the use of HPDs, the majority of respondents (68%) indicated the affirmative, with only 13% disagreeing and 11% unsure (Table 15).

Table 15 Reported Opinion on whether Anything could be done to Influence the Use of Hearing Protection Devices amongst Miners

Opinion on whether anything could be done to influence the use of HPDs		
	Number	**%**
Yes	69	68%
No	13	13%
Don't know	11	11%
Illegible/ blank/ N/A	8	8%
Total	**101**	**100%**

These responses suggest a willingness amongst the majority of participants in the study to welcome new ideas and information as well as possible methods and means of awareness, education and training on NIHL. This positive attitude should be exploited to achieve this end for the good of the study population.

8.4.5 Preference for method of education regarding hearing protection devices

The current medium of education is computer-assisted training on an individual basis using interactive software developed specifically for miners and that takes cognisance of prevailing literacy and numeracy levels. Whilst a large proportion of respondents (36%) preferred education in this manner, the majority of respondents preferred a different medium of education on this subject (Table 16).

Table 16 Miners' Preferred Medium of Education on Hearing Protection Device usage

Preferred medium of education regarding HPD use		
	Number	**%**
Personally in large groups	13	12%
Personally in small groups	7	6%
Personally on a 1 on 1 basis	44	39%
Other means such as during computer assisted training, videos, etc.	40	36%
Illegible/ blank/ N/A	8	7%
Total*	**112**	**100%**

* Some respondents offered more than one response

These findings suggest that whilst the current medium of education (computer-assisted training) is popular, other methods are likely to increase acceptance amongst a greater proportion of respondents. For example, the majority of respondents would prefer personal one-on-one sessions (39%) or training in large groups, facilitated by a person instead of a computer facilitated (12%). This finding points to a suboptimal satisfaction with the current medium of education, a fact which may be responsible for negative attitudes towards the training programme and, consequently, the deficiencies in knowledge discussed above.

8.4.6 Preference for who should carry out the educating

Whilst the current trainers (a dedicated training department at the mine) are the most popular choice for training and educating (28%), Occupational Health Staff (23%), direct supervisors (21%) and safety staff (18%) comprised a high proportion of responses (Table 17).

Table 17 Preference for Who should carry out the Hearing Protection Device Education

Preferred Trainers /Educators		
	Number	**%**
Occupational Health staff	37	23%
Clinic or hospital staff	7	4%
Safety staff	29	18%
Training staff	44	28%
Direct Supervisor	33	21%
Other	4	3%
Illegible/ blank/ N/A	6	4%
Total*	**160**	**100%**

* Some respondents offered more than one response

This finding points to a potential lack of credibility or acceptance of the current training staff amongst a significant proportion of participants and, therefore, the possible lack of effectiveness of the programme, which may contribute to the aforementioned deficiencies in knowledge amongst participants despite the apparent numerous training sessions undergone. In attempting to improve this situation, it is necessary to consider alternative trainers for NIHL education.

8.4.7 Summary of findings relating to reported attitudes of participants towards noise induced hearing loss and the use of hearing protection devices

The above data suggest that attitudes towards HPD usage are generally constructive and positive as suggested by the reported relative importance of NIHL compared with other workplace health hazards, the reported self assumed responsibility for NIHL and the appropriate reasons given for using HPDs. Also, the majority of respondents generally reported a confidence that something could be done to influence the use of HPDs in their setting. Therefore, the low observed usage of HPDs in this study is unlikely to be due to poor attitudes towards NIHL and HPD usage. Careful consideration of the medium of training and who does the training is required, since most respondents indicated a preference for training to be carried out in different ways and by different trainers.

8.5 Factors affecting the Use / Non-use of Hearing Protection Devices

The preceding data demonstrate that whilst respondents appear to know that it is expected of them to use HPDs at work, and reporting that they do so, in practice observed usage is nearly half the rate of reported use (93% vs. 50% - Table 2). As discussed above, the reported lack of knowledge of the noise hazard and apparent lack of recognition of the workplace as noisy have been suggested as possible explanations for this finding. The following section considers whether barriers to access to HPDs are further reasons for non-usage of HPDs and offers further explanations and insights into possible causes of this failure of the HCP. The section is analysed by considering availability of HPDs, availability of HPDs free of charge, refusal of access to HPDs and availability of more than one type of HPD:

8.5.1 Availability of hearing protection devices amongst miners interviewed

Whilst the majority of respondents (91%) indicated that HPDs were always available to them, the fact that 6% responded to the contrary is indicative of a possible barrier to access of devices by those requiring them (Table 18).

Table 18 Reported Availability of Hearing Protection Devices

Reported Availability of HPDs		
	Number	**%**
Available	92	91%
Unavailable	6	6%
Illegible / blank / N/A	3	3%
Total	**101**	**100%**

This reported inaccessibility of HPDs to workers, whether real or merely perceived, is important in that it suggests a barrier to access and, therefore, needs to be remedied, irrespective of the actual magnitude of this inaccessibility. The distribution network should be expanded to take into account ease of access and uninterrupted supply of HPDs, if necessary. Workers should also be made aware of the sources from which these devices may be obtained so as to negate any perceived unavailability.

8.5.2 Access to hearing protection devices

Five per cent of respondents reported that they were refused HPDs when they requested them, at least once (Table 19). Whilst this proportion may seem low, it is important nonetheless in that it may result in workers not accessing HPDs for fear of refusal. This finding may potentially, therefore, result in a tendency not to attempt to access HPDs by people who have previously been refused them, as well as those they may have shared their experience with, resulting in a further non-usage of HPDs and risk of developing NIHL.

Table 19 Reported Refusal of Access to Hearing Protection Devices

Ever Refused HPDs		
	Number	**%**
Yes	5	5%
No	93	92%
Illegible / blank / N/A	3	3%
Total	**101**	**100%**

Although the proportion in the categories of respondents who report HPDs not being available and having been refused HPDs appears relatively small, the magnitude of this problem should not be underestimated when it is extrapolated to the study population. If the study sample is representative of the study population (as is being suggested), the implication is that almost 750 employees may share this experience and may therefore be subject to real or perceived barriers to access to HPDs. Furthermore, the statistically significant correlation between the two categories obtained on cross-tabulation (Table 20) (p=0.001) lends support to the importance of this finding.

Table 20 Cross-tabulation Report of Availability of Hearing Protection Devices versus Refusal of Access to Hearing Protection Devices

		Are HPDs available whenever you want them?		
Have you ever been refused HPDs?		**Yes**	**No**	**Total**
	Yes	3	2	5
	No	89	4	93
	Total	**92**	**6**	**98**
Probability Level = 0.001				

8.5.3 Availability of hearing protection devices free of charge

Notwithstanding the aforementioned reported barriers to access, almost all respondents reported that HPDs were available free of charge, which is in keeping with the policy at this study site and suggests that when and where these devices are available, they are free of charge. Hence, cost is not a barrier to access (Table 21).

Table 21 Availability of Hearing Protection Devices Free of Charge

Availability of HPDs Free of Charge		
	Number	**%**
Available	96	95 %
Unavailable	1	1 %
Don't know	1	1 %
Illegible / blank / N/A	3	3 %
Total	**101**	**100 %**

8.5.4 Availability of a range of hearing protection devices

Table 22 Availability of More than one Type of Hearing Protection Device

How many types of HPDs are available from the mine?		
	Number	**%**
One type only	32	32%
More than one type	68	67%
Illegible/ blank/ N/A	1	1%
Total	**101**	**100%**

The data in Table 22 suggest that nearly one third of respondents (32%) reported that only one type of HPD was available to them. Since the mine's HCP makes provision for more than one type of HPD to be available to employees based on the widely accepted understanding that just one type may not meet the requirements of a spectrum of anthropomorphically different individuals. The reported finding, therefore, highlights another reported barrier to access to appropriate HPDs. Once again, whilst the reality of this barrier is beyond the scope of this report (compared with the possibility of it only being a perceived barrier), perception does equal reality in the case of workers who have this perception. Hence, the perception of unavailability for those who reported such acts as a limiting factor (or barrier) to their accessing these devices should they need to and, as such, represents a barrier to access for them. This perceived barrier, therefore, remains an issue to be addressed through either improving access to multiple types of HPDs or awareness of the location of these offerings.

8.5.5 Summary of findings relating to factors affecting the use / non-use of hearing protection devices

It is evident from the above data that a small but significant proportion of respondents perceived unavailability of HPDs in general (6%) and more than one type of HPD in particular (32%) as constituting barriers to access to these devices. Furthermore, 5% of respondents reported having been refused HPDs. These factors constitute barriers to access to these devices and need to be addressed in order that the HCP at the study site can be improved.

8.6 Reported Reasons for not Using Hearing Protection Devices

Whilst the aforementioned sections suggest reasons derived from the data for respondents not using HPDs as often as required, the following section outlines reported reasons for not using these devices. These responses are considered in the context of reported reasons for not ever using HPDs and reported reasons for not using HPDs for an entire shift. These questions have been included in order to ascertain exact reasons for non-usage taking cognisance of suspected reasons based on anecdotes such as possible discomfort associated with the use of HPDs, perceived interference of HPDs with hearing danger signals and other postulated reasons (See Section 2.8).

8.6.1 Reported reasons for not using hearing protection devices

Table 23 Reported Reasons for not Using Hearing Protection Devices

Reported reasons for not using HPDs*				
	Reasons for not using HPDs at all		Reasons for not using HPDs for the	
	Number	%	Number	%
Uncomfortable	15	50%	23	40%
Interfere with warning signals	7	23%	8	14%
They fall out of the ears	3	10%	11	19%
They don't work	4	13%	6	11%
Other	1	3%	9	16%
Total	**30**	**100%**	**57**	**100%**

* Owing to the high proportion of not applicables, only applicable responses are considered. Reasons were offered by those who indicated that they did not use HPDs as well as those who indicated that they did.

With regard to using HPDs at all, the majority of responses (50%) cited the discomfort of these devices (Table 23) as the reason for non-usage. Almost a quarter of respondents (23%) indicated a perception that these devices interfered with their hearing warning signals, whilst 13% indicated a perception that the devices did not work. Ten per cent of respondents reported that their HPDs fell out. These are all important reasons for not using HPDs and should be addressed in order to increase the uptake of usage of these devices. Because of the difference in anatomy between individuals, a range of HPDs is required to improve the chances of all individuals to find suitably comfortable devices to use. This intervention will also decrease the likelihood of such devices falling out

during use. The perception that these devices interfere with warning signals or do not work are erroneous and can be addressed through appropriate education and training.

With regard to reasons for not using HPDs for the entire shift, the findings from the data in Table 21 indicate relative consistency between the reasons offered by respondents for not using HPDs at all and for not using HPDs for the entire shift. Discomfort (40%), perceived interference with warning signals (14%), falling out during usage (19%) and the perception that HPDs do not work (11%) account for the majority of reported reasons.

As with the reported reasons for not using the devices at all, these factors offer significant insight into the drivers of not using HPDs for an entire shift, whilst also offering the opportunity for addressing the barriers to use.

8.6.2 Supervision of hearing protection device usage

Whilst the previous two subsections were aimed at understanding the reasons for non-usage from a voluntary perspective, the data set out in Table 24 assess the reasons for non-usage by considering the enforcement of use.

Table 24 Supervision of Hearing Protection Device Usage

Does anyone check whether you use HPDs?		
	Number	**%**
Yes	62	61%
No	33	33%
Illegible/ blank/ N/A	6	6%
Total	**101**	**100%**

The data presented in Table 24 can be interpreted in one of two ways: on the one hand it could be argued that the fact that 61% of respondents pointed to no supervision or checking of their use of HPDs in the workplace could indicate a lack of enforcement as a contributory factor to the low observed usage. This finding, it could be argued, may culminate in a lack of positive reinforcement that could be created by regular inspections. On the other hand, it may be argued that despite the reported checking up on 61% of respondents, the observed usage is

still very poor, thus pointing to a failure of this approach to drive the desired behaviour (i.e. the use of HPDs).

The former (paternalistic) viewpoint, which is predicated on a form of coercion, is inappropriate in an environment where the use of HPDs is likely to be sustainable if it is driven through the empowerment created by understanding amongst users. The latter approach would also have the advantage of opening the possibility of wider health promoting behaviour beyond HPD usage, whereas the former paternalistic approach is less likely to achieve this. That having been said, even in an environment of personal empowerment there is a role for checking on the use of HPDs both for the purposes of monitoring interventions as well as for improving the chances of sustainability of this practice. A balance can be achieved through positive reinforcement rather than broad punitive measures.

Of significance to this argument is the finding that of those who admitted to being checked on and who responded to this question, the majority of 'enforcers' (63%) were supervisors, with only 13% of respondents reporting that their co-workers checked on their use of HPDs (Table 25). The "other" was not specified.

Table 25 Who Supervises the Use of Hearing Protection Devices

Who Checks on the Use of HPDs?		
	Number	**%**
Supervisors	45	63%
Co workers	9	13%
Ventilation / safety officer	2	3%
Other	15	21%
Total*	**71**	**100%**

* Because of the high proportion of N/As, only applicable responses are considered. Some respondents provided more than 1 response

This finding points to a lack of consideration of respondents for the use of HPDs by their co-workers, which suggests a 'hands off' culture concerning HPD usage at this study site. The finding of 93% reported use (Table 2) suggesting that participants know that HPD usage is desired in the workplace, coupled with the low reported 'enforcement' by co-workers reinforces suggestions of this 'hands off' culture.

8.6.3 Summary of findings relating to reasons for not using hearing protection devices

In summary, the data suggest that inaccessibility of HPDs, refusal of access to them and availability of only one type of HPD serve as reasons for their non-usage, albeit only in a relatively small proportion of participants in the case of the two former factors. The main reported reason for not using HPDs for the entire shift and even for not using HPDs at all is the reported discomfort of the devices available, reported by almost half of the study participants. This finding is followed by the incorrect perception that HPDs interfere with the ability to hear warning signals and the reported incorrect fitting of these devices that causes them to fall out of the ears during use. It was also reported by almost two thirds of respondents that HPD usage is checked on and that this is done mainly by supervisors. Whether or not this latter finding actually counts as a reason for non-use is arguable but what is more likely is that a culture of co-workers looking out for each other in terms of HPD usage is probably lacking.

At this stage it is again worth noting that despite the aforementioned likely causes of non-usage of HPDs there is a strong base to be built on in the form of an indicated acceptance of responsibility for their hearing by miners, as well as a reported understanding of NIHL as (generally) being at least as important as other workplace injuries and diseases. These findings suggest that education and training initiatives aimed at building a ‘hands on’ culture where miners are looked upon to use HPDs for their own good and create a sustainable culture of using HPDs through co-worker involvement, may be readily embarked upon.

8.7 Summary of Results and Analysis

A large proportion of respondents who reported using HPDs when exposed to noise who were not observed to be doing so in this study. Furthermore, of those who reported using HPDs many reported not doing so continuously throughout the shift, or consistently over their shifts throughout a given week. These findings explain the persistence of NIHL in this group.

In terms of knowledge amongst this group; the majority of participants reported that they knew of the potential of noisy work to damage hearing, the benefits of using HPDs, and that their workplaces were 'noisy'. However, a significant minority reported a lack of knowledge around these issues as well as knowledge of correct insertion, cleaning and storage of HPDs. A significant proportion of participants also claimed never to have been educated about HPDs at induction (when they should have been, according to the mine procedures).

In terms of attitudes towards NIHL and HPD usage, the data suggest that most participants considered NIHL at least as important as other workplace injuries and illnesses and also indicated that they believed miners themselves to be responsible for their hearing. The majority of respondents also indicated a perception that something could be done to influence the use of HPDs in their setting. Most respondents indicated a preference for training around NIHL and HPD usage to be done in different ways and by different trainers to those currently being used.

A small but significant proportion of respondents reported unavailability of HPDs in general (6%) and unavailability of more than one type of HPD in particular (32%) whilst 5% of respondents reported having been refused HPDs. These factors constitute barriers to access to these devices.

In terms of cited reasons for not using HPDs, the main reported reasons for not using HPDs at all or for the entire shift are: discomfort of the available devices, amongst almost a half of the respondents; the incorrect perception that HPDs interfere with the ability to hear warning signals; and the reported falling out of these devices during use.

Almost two thirds of respondents reported being checked on for HPD usage, predominantly by their supervisors.

9 CONCLUSION

9.1 Hearing Protection Device Usage

Reported use of Hearing Protection Devices (HPDs) is high at 93% but this is nearly twice the rate of actual observed usage amongst participants, which totalled only 50%. This finding suggests that participants in this study do not always use HPDs when they should. Fifty per cent is an inappropriately low rate of usage since all participants should ideally have been using HPDs. Only 24% of respondents reported using HPDs consistently at work and 31% reported using HPDs continuously throughout the whole shift. These findings explain the persistence of noise induced hearing loss (NIHL) as outlined in Section 2 of this report.

These findings are, however, slightly better than those reported in international studies for both reported usage and observed usage (See Section 2.5). As far as comparable South African results are concerned, the only study amongst South African miners that could be found reported a 75% self-reported usage rate (Kahan & Ross 1994). Observed usage was not established in this study. Hence, whilst disappointingly low, the pattern of high reported and much lower observed HPD usage rates seen in the current study are consistent with available international literature on the subject.

9.2 Knowledge

Knowledge amongst participants of the benefits of using HPDs as well as the potential of noise to cause hearing loss was relatively high at 89% and 82%, respectively. Whilst lower levels of knowledge of NIHL has been reported in the literature for recreational-noise exposure, high levels of knowledge amongst occupationally exposed groups is consistent with international and local reports (Section 2.5). This finding is, however, contradictory to the findings of Kahan & Ross (1994) who reported that South African mineworkers were poorly informed regarding the fact that noise was a health hazard and points to the possibility of

an improvement in getting this message to miners having taken place since that study was concluded in 1994.

Despite this reportedly good knowledge of the benefits of HPDs and the potential for noise to damage hearing there was found to be a small but significant proportion who reported not knowing that noise can cause hearing loss (11%) and not knowing or being unsure of the benefits of HPDs (3% and 6% respectively). There was also another small but significant group (8%) who reported not having been educated about the benefits of HPDs, which is also cause for concern in view of the current practice of training each individual at initial induction and then subsequently upon that person returning from annual leave thereafter. Furthermore, knowledge of insertion, cleaning and storage of HPDs, as well as knowledge of the workplace as being noisy, is poor. For example, 13% of respondents reported that their workplaces were not noisy whilst an additional 2% of respondents were unsure whether their workplaces were noisy or not.

Hence, even though these respondents may have good knowledge of the benefits of HPDs and the ability of noise to damage hearing, they may not be using HPDs simply because they do not perceive a noise hazard in their own workplaces, when in fact this hazard is present, a fact which therefore places these individuals at an increased risk of developing NIHL. This finding differs from the findings of Kahan & Ross (1994) who reported that almost 77% of participants felt that they worked in a noisy place, but is consistent with findings reported in the national and international literature on the subject. For example, Kielblock & Van Rensburg (1988) found that 80% of South African miners interviewed did not consider noise to be a “problem” in their jobs whilst Leinster et al (1994) found in a large study across 48 organisations in Britain that much of the time neither managers nor the workforce were conscious of the noise hazard.

This reported poor appreciation of the noisiness of the workplace highlights the fact that knowledge of the adverse heath effects of noise alone is not sufficient to prompt behavioural change in the form of usage of HPDs at times of perceived vulnerability to NIHL. The poor appreciation also supports the view that even when knowledge of the noise hazard exists, it is not necessarily the driving force in determining behaviour with respect to use of HPDs.

All of the above suggest that the current training programmes in place at the study site are lacking in terms of several key outputs. These include education of the benefits of HPDs, knowledge of the workplace as noisy, knowledge relating to insertion, and actually educating all exposed workers about the benefits of using HPDs. While the last of these appears to be somewhat mitigated by education by other sources (particularly Occupational Health Centre staff), this should really be adjunctive to the primary education undertaken at initial and subsequent annual induction which all miners are obliged to undergo. Hence, there is a need to evaluate the current training programme from an outcomes point of view with the aim of improving the quantity and quality of education and training around these issues. There is also merit in strengthening the adjunctive educational areas and improving their ability to provide appropriate training and education on this subject, to reinforce the primary education. Furthermore, such adjunctive training at the Occupational Health facilities has the added benefit of allowing prioritisation of individuals and groups who may be found to have early NIHL as a result of individual susceptibility or any other reason, thereby preventing the progression of early NIHL in predisposed individuals.

Finally, the fact that 8% of respondents claimed never to have had explained to them the benefits of HPDs despite the high average length of service amongst respondents of 10 years in their current job and 14 years average service in the mining industry points to a need to investigate whether or not the annual refresher courses are actually taking place and, if they are, what the reasons are for the low reported education at these sessions.

In summary, the data regarding knowledge of miners interviewed in this study suggest that knowledge of noise as a hazard and the benefits of HPDs were relatively good compared with other local and international benchmarks but that recognition of the workplace as being noisy was generally poor.

9.3 Attitudes

The majority of participants in this study (68%) reported that NIHL was as important as other workplace injuries and illnesses, whilst a further 18% reported that it was more important than these. Whether or not these responses were in any way influenced by the study's focus on NIHL, this response represents a vast majority and suggests that these miners regard NIHL highly amongst the known workplace health hazards. In addition, the responses of the vast majority of participants (92%) indicating that the responsibility for NIHL lies with miners themselves, suggests an acceptance of the (at least partial) need for self-intervention in order to address this issue.

9.4 Reasons for not using Hearing Protection Devices

As discussed in Section 2.8 of this report, the reasons for non use of HPDs may be divided into personal and environmental factors. In terms of personal reasons, the main issue raised is that of the reported lack of recognition of the workplace as being noisy and therefore being potentially damaging to hearing. The data did not provide any reason to suggest that any other individual factors such as perceived benefits or efficacy of use of HPDs are largely responsible for the failure to consistently use HPDs when necessary.

Instead, it is the so-called environmental factors which appear to be the main drivers of this behaviour: In response to the direct question of why respondents did not use HPDs, the majority of responses (50%) cited discomfort of these devices as the reason. Almost a quarter of respondents (23%) indicated a perception that these devices interfered with their hearing warning signals whilst 13% indicated a perception that the devices did not work. Ten per cent of respondents reported that their HPDs fell out. These are all important reasons for not using HPDs and should be addressed in order that the uptake of usage of these devices can be increased. Because of the anthropomorphic differences between individuals, a range of HPDs is required to improve the chances of all individuals finding suitably comfortable devices to use. This intervention will also

decrease the likelihood of such devices falling out during use. The perception that these devices interfere with warning signals or do not work are untrue and can be addressed through appropriate education and training.

A small but significant proportion of respondents reported unavailability of HPDs (6%) and being refused HPDs (5%) as reasons for not using these devices. These reasons when combined with the 32% of responses which indicated that only one type of HPD was available combine to highlight significant barriers to access to appropriate HPDs in this setting on a numerical scale if not on a statistical one (as a result of the relatively low percentages in the case of the former). Furthermore, arguably the main underlying reason for non-usage of HPDs at this site is the suggestion that there is a general 'hands off' culture when it comes to the use of HPDs. This is evidenced by the good knowledge of the necessity to use HPDs but the low reported checking of use by co-workers. Instead, the majority of checks on the use of HPDs are reportedly done by supervisors (almost two thirds), a fact which may paradoxically lead to a lowering of the rate of usage, should this checking be seen as part of a punitive process and rebelled against by workers. It would be far better to create a culture of checking on use by co-workers rather than supervisors, thereby changing the negative driver to a positive one, ie caring for one's co-workers' hearing as well as one's own. If successful, this could possibly also have the added benefit of spilling over to other health and safety behaviours, thereby improving other elements of health and safety at work which are undoubtedly benefited by positive reinforcement rather than negative 'policing'.

Hence, the reported partial failure of hearing conservation programmes (HCPs) may be explained by findings of this study; NIHL continues to occur because of overexposure to noise in the workplace. Whilst HPDs may prevent (most if not all of) these cases, they are not as effective as they could be because they are not used by all exposed people constantly and consistently during exposure to hazardous noise, notwithstanding the good reported knowledge of the potential of noise to damage hearing and the benefits of using HPDs, the reported high prioritisation of NIHL compared with workplace injuries and illnesses, and the self-assumed responsibility for NIHL amongst the study sample. This shortcoming is compounded by: actual or perceived barriers to access to HPDs

in terms of unavailability of these devices and refusal to provide access to them amongst a small but significant proportion of respondents; and a lack of variety of HPDs to choose from in order to improve the likelihood of finding a comfortable fit. These factors would explain the identified lack of usage of these devices amongst a large proportion of the study sample largely as a result of uncomfortable HPDs. This tendency to not use HPDs when needed is exacerbated by an erroneous perception that these devices impair the ability of users to hear warning signals or effectively communicate whilst using them. All of these factors are also exacerbated by a likely culture which supports supervisory checks on the use of HPDs but which does not promote the checking of use by co-workers, thereby implying a top-down approach rather than promoting positive reinforcement of health maintaining behaviour such as the use of HPDs.

The indicated preference for alternative trainers and alternate media of training by the majority of respondents is a further significant finding, suggesting a lack of total acceptance of the training status quo, and the consequent possible ineffectiveness of the current training programme.

10 RECOMMENDATIONS

Whilst this paper concentrates on the use of hearing protection devices (HPDs) it should be borne in mind that personal protective equipment (PPE) such as HPDs should only be the last resort in addressing noise at work and the prevention of noise induced hearing loss (NIHL) (See Section 2.9) and that all such interventions would be unnecessary had the preceding ones in the hierarchy of noise control been successful. Hence, any and all HPD interventions, however well intentioned they may be, are still only to be undertaken after the aforementioned hierarchy of controls and hence the boundaries of reasonable practicability should constantly be challenged and surpassed to eliminate or reduce the source of the hazardous exposure rather than attempt to mitigate its effects.

That having been said, the topic of this research relates to an aspect of prevention of NIHL requiring the use of HPDs and therefore the following recommendations relate to findings around such use.

The following is an abbreviated set of recommendations aimed at increasing the appropriate use of HPDs: (Please see Appendix D for a more comprehensive set of recommendations).

10.1 Recommendations Relating to Increasing Usage

10.1.1 Review of the current education and training programme

It is recommended that it be verified that all employees are indeed attending and successfully completing the training they are meant to be undergoing at initial induction and refresher induction annually thereafter.

It is also recommended that the induction programme be reviewed with particular reference to education on NIHL and HPD usage, including the quality and quantity of the curriculum, ways of improving training with improved outcomes, increasing knowledge of the benefits of HPDs and training in the necessity for consistent and constant use whenever exposure to hazardous noise occurs. Possible cultural or language barriers in the training process should be investigated and addressed, as should instruction on the correct

method and habit of use of insertion, cleaning and storage of HPDs. Education around non-occupational noise-exposure and its potential for causing NIHL should be included in the training programme.

Furthermore, consistency of training objectives should be ensured both within the induction programme and across all groups of people who are training, thus promoting positive reinforcement.

Clearly demarcating and indicating noise zones through the extensive use of uniform universal noise zone signage is recommended to improve awareness of the noise hazard to employees entering such noise zones.

It is recommended that trade unions and associations, and health and safety committees be included in all initiatives at the mine to address NIHL.

10.1.2 Consider complementary methods of training

Whilst the current method of training using computer-assisted modules which has apparently been researched and developed for this specific environment are popular amongst a large proportion of those interviewed, this is not true for the entire study sample and, therefore, study population. Hence, it comes as no surprise that 44% of respondents would prefer to be trained personally on a one-on-one basis and 13% would rather be trained personally in large groups. Hence, it is recommended that the site offers personal training on a one-on-one basis to workers who would prefer this medium of instruction over the current computerised training.

It is also recommended that the mine actively attempt to create a culture of checking on co-workers' use of HPDs, thereby departing from 'enforcement' and 'hands off' to personal empowerment and co-worker involvement. The aim should be to make the use of HPDs 'the norm' and getting people to take on the responsibility for checking on the use of HPDs by their co-workers in addition to themselves.

Promoting and incentivising the checking of use of HPDs by co-workers, would promote positive reinforcement of this behaviour and it is recommended that the mine considers incentivising the use of HPDs through a performance-based

management system with an emphasis on team-based reward programmes for adhering teams.

Coupling HPD usage with other health and safety behaviour initiatives is recommended as it is likely to be seen as part of total worker health and safety rather than an isolated initiative.

Greater use of various methods of education such as billboards, posters, advertisements in the company newsletters and local radio stations is recommended to spread the message further.

10.1.3 Consider alternative educators and trainers

It is recommended that the mine consider changing the 'primary' training from the current computerised system to a non-computerised training programme and also that the mine support these 'primary' training initiatives with strong adjunctive training at the Occupational Health Centres (as preferred by 24% of respondents), direct supervisors (as preferred by 21% of respondents), and Safety staff (as preferred by 19% of respondents). Furthermore, it is essential to identify high-risk or particularly susceptible individuals or groups such as those with early NIHL and counsel them about their risks and alternatives for preventing hearing deterioration. This counselling can be done at the Occupational Health Centres at periodical medical examination after routine audiometry is conducted on employees as part of statutory medical surveillance.

To improve acceptance of education and mitigate possible language barriers in communication, it is recommended that 'peer educators' (as are used in HIV counselling settings) be used to counsel workers about the risks of developing NIHL. Similarly, 'people living with NIHL' (similar to 'people living with HIV and AIDS') should be considered as part of the overall education campaign, to drive home the relevance of this condition to the workforce.

It is recommended that trade unions and associations and health and safety committees at the mine should (ideally) drive or (at least) support all initiatives, thereby making this a multi disciplinary and multilateral approach.

10.1.4 Increased emphasis on prevention

Following the principle of 'prevention is better than cure', every available relevant opportunity should be used to educate people and improve awareness around NIHL. These include but are not limited to every visit to the workplace Occupational Health facilities, workplace medical facilities and Union and Associations' offices.

10.2 Recommendations Relating to Removing Barriers to Usage

In improving the mine's HCP it is important to remove actual barriers to access of HPDs by ensuring that all workers have access to a constant and consistent supply of a range of HPDs free of charge whenever they are exposed to noise in the workplace.

It is also important to address and remove perceived barriers to access of HPDs by making workers aware of the sources from which these devices may freely be obtained, and putting in place a workable and practical system whereby workers can report the unavailability of HPDs

All of the above need to be based on the following health promotion principles:

- Make the correct practice the easy practice;
- Provide large scale awareness;
- Provide personal (one on one) education where necessary; and
- Provide an environment of positive reinforcement of healthy behaviour including the use of HPDs.

11 SUGGESTED FURTHER RESEARCH

- Knowledge of and attitudes towards noise induced hearing loss (NIHL) and hearing protection device (HPD) usage are good but practice is poor. Therefore further research into the behavioural change model and dynamics around NIHL and HPD usage is recommended.
- Notwithstanding the moral priority of implementing initiatives to eliminate noise rather than improve the use of PPE, comparing the cost effectiveness, cost benefit and cost utility of interventions aimed at reducing noise against those aimed at improving HPD usage is worthwhile.
- Research into the functional impact on vocational and daily living of individuals with NIHL would provide valuable insight into assisting those with this condition, as well as improve education initiatives.

12 REFERENCES

Bogoch, I.I., House, R.A. & Kudla, I. (2005): Perceptions about hearing protection and noise-induced hearing loss of attendees of rock concerts. *Canadian Journal of Public Health,* Jan-Feb, 96:69-72.

Brungart, D.S., Kordik, A.J. & Simpson, B.D. (2004): The effects of single and double hearing protection on the localization and segregation of spatially separated speech signals. *Journal of the Acoustic Society of America,* Oct, 116:1897-900.

Cheung, C.K. (2004): Organizational influence on working people's occupational noise protection in Hong Kong. *Journal of Safety and Rescue,* 35:465-75.

Crandell, C., Mills, T.L. & Gauthier, R. (2004): Knowledge, behaviors, and attitudes about hearing loss and hearing protection among racial / ethnically diverse young adults. *Journal of the National Medical Association,* Feb, 96:176-86.

Franz, R.M. & Phillips, J.I. (2001): Noise and Vibration, *in SIMRAC Handbook of Occupational Health Practice in the South African Mining Industry,* Guild, R., Ehrlich, R.I., Johnstone, J.R. & Ross, M.H. (Eds), First Edition, Johannesburg: Published by the Safety in Mines Research Advisory Committee, 193-218.

Kahan, E. & Ross, E. (1994): Knowledge and attitudes of a group of South African mine workers towards noise induced hearing loss and the use of hearing protective devices. *South African Journal of Communication Disorders,* 1994:41: 37-47.

Kielblock, J. & Van Rensburg A (1998): The implementation and control of hearing conservation programmes with reference to the South African industry: *Mines Safety and Health Proceedings.* Johannesburg: Chamber of Mines of South Africa, 129 – 135.

Zinser, E. (1999): Report on the promotional launch: Hearing Conservation Programme: GEN 011. *Safety in Mines Research Advisory Committee Newsletter*, October 1999 – January 2000: 1.

Landen, D., Wilkins, S., Stephenson, M. & McWilliams, L. (2004): Noise exposure and hearing loss among sand and gravel miners. *Journal of Occupational and Environmental Hygiene,* Aug, 1: 532-41.

Leinster, P., Baum, J., Tong, D. & Whitehead, C. (1994): Management and motivational factors in the control of noise induced hearing loss (NIHL).

Lusk, S.L., Ronis, D.L., Kazanis, A.S., Eakin, B.L., Hong, O. & Raymond, D.M. (2003): Effectiveness of a tailored intervention to increase factory workers' use of hearing protection. *Nursing Res,* Sep-Oct; 52(5): 289-95.

Lusk, S.L. & Kelemen, M.J. (1993): Predicting use of hearing protection: a preliminary study. *Public Health Nursing,* Sep;10(3): 189-96.

Maisarah, S.Z. & Said, H. (1993): The noise exposed factory workers: the prevalence of sensori-neural hearing loss and their use of personal hearing protection devices. *Medical Journal of Malaysia,* Sep;48(3): 280-5.

McBride, D.I. (2004): Noise-induced hearing loss and hearing conservation in mining. *Occupational Medicine,* Aug; 54(5): 290-6.

Murray-Johnson, L., Witte, K., Patel, D., Orrego, V., Zuckerman, C., Maxfield, A.M. & Thimons, E.D. (2004): Using the extended parallel process model to prevent noise-induced hearing loss among coal miners in Appalachia. *Health Educational Behaviour,* Dec, 31:741-55.

Neitzel, R. & Seixas, N. (2005): The effectiveness of hearing protection among construction workers, *Journal of Occupational and Environmental Hygiene,* April, 2: 227-38.

NIOSH (United States National Institute for Occupational Safety and Hygiene). *Hearing Loss Prevention Highlights,* www.cdc.gov/niosh/mining/highlights/hearing_loss_prevention_highlights.htm.

Patel, D.S., Witte, K., Zuckerman, C., Murray-Johnson, L., Orrego, V., Maxfield, A.M., Meadows-Hogan, S., Tisdale, J. & Thimons, E.D. (2001): Understanding barriers to preventive health actions for occupational noise-induced hearing loss. *Journal of Health and Communication*, Apr-Jun; 6(2): 155-68.

Pessina, D. & Guerretti, M. (1999): Effectiveness of Hearing Protection Devices in the Hazard Reduction of Noise from Used Tractors. *Journal of Agricultural Engineering Research,* 75: 73-80.

Rabinowitz, P.M. & Duran, R. (2001): Is acculturation related to use of hearing protection? *American Industrial Hygiene Association Journal,* Sep-Oct; 62(5): 611-4.

Shearer, S. (1992). The Sound of Silence. *Gold Fields Review* 1991-1992. 65 – 70.

Schmidt, J., Royster, L. & Pearson, R. (1980): Impact of an industrial hearing conservation programme on occupational injuries for males and females. *Journal of the Acoustic Society of America,* 1980; 67(Suppl 1): S 59.

Stephenson, M.T., Witte, K., Vaught, C., Quick, B.L., Booth-Butterfield, S., Patel, D., Zuckerman, C. (2005): Using persuasive messages to encourage voluntary hearing protection among coal miners. *Journal of Safety and Rescue,* 36: 9-17.

Svensson, E.B., Morata, T.C., Nylén, P., Krieg, E.F. & Johnson, A.C. (2004): Beliefs and attitudes among Swedish workers regarding the risk of hearing loss. *International Journal of Audiology,* Nov-Dec, 43: 585-93.

Widén, S.E. & Erlandsson, S.I. (2004): The influence of socio-economic status on adolescent attitude to social noise and hearing protection. *Noise and Health,* Oct-Dec, 7:59-70.

Williams, W., Purdy, S., Murray, N., LePage, E. & Challinor, K. (1993): Hearing loss and perceptions of noise in the workplace among rural Australians. *Australian Journal of rural Health,* Jun;12 (3): 115-9.

APPENDIX A - NIHL AND HPD QUESTIONNAIRE

Questionnaire No: _____ Date: ___/___/ 2005 Day: _____

Time: _____am/ pm Interviewer: _____

Interviewer, please CIRCLE appropriate responses, and FILL IN participant's responses where specified. With open ended questions please be patient in allowing respondents to answer questions fully. With closed ended questions do not lead respondents by prompting them with suggested answers.

SECTION 1: DEMOGRAPHIC INFORMATION

(1) Where are you from?

(1) Lesotho
(2) Mozambique
(3) Eastern Cape Province
(4) Gauteng Province
(5) North West Province
(6) Free State Province
(7) Botswana
(8) Other

(2) What was your age at your last birthday? _____ (years)

(3) Where do you work?

(1) Underground
(2) Surface

(4) What is your category of employment?

(1) Full Time employee
(2) Contractor

(5) What type of job do you do _____

_____

(6) How long have you been doing your present work? _____(years)

(7) Which year did you first begin working in the mining industry? _____

SECTION 2: KAP Survey

(8) Do you think that you work in a noisy environment?

(1) Yes

(2) No

(3) Don't know

(9) Do you think that the noise you are exposed to in your daily work can damage your hearing?

(1) Yes

(2) No

(3) Don't know

(10) Have you been explained the benefits of using hearing protection devices?

_____

_____

(11) If Yes, By whom (Interviewer, circle as many as appropriate)

(1) During induction at the mine?

(2) By your supervisor?

(3) By your co-workers?

(4) Medical staff at the mine health care facilities?

(5) Medical staff at the Occupational Health Centres?

(6) Other?_____

(12) If yes, did they say that wearing hearing protection devices is good for your health?

(1) Yes

(2) No

(3) Don't know

(13) If no, what did they say? ***(Please explain)***

_____

_____

(14) How many different types of hearing protection devices are you able to get from the mine?

(1) One only

(2) More than 1

(15) Have you been shown how to insert your hearing protection devices into your ears?

(1) Yes

(2) No

(16) Have you been shown how to clean your hearing protection devices?

(1) Yes

(2) No

(17) Have you been shown how to store your hearing protection devices?

(1) Yes

(2) No

(18) Do your co-workers think it is beneficial to use hearing protection devices?

(1) Yes

(2) No

(3) Don't know

(19) If yes, why? ***(Please explain)***

_____

_____

(20) If no, why not? ***(Please explain)***

_____

_____

(21) Do your co-workers use hearing protection devices?

(1) Yes

(2) No

(3) Don't know

(22) If yes, why? ***(Please explain)***

_____

_____

(23) If no, why not?

(1) They are uncomfortable

(2) Cannot hear warning signals when using them

(3) They fall out

(4) They do not work

(5) Other_____

(24) If yes, how often do your co-workers use hearing protection devices?

(1) All the time at work

(2) Every day but only when there is a lot of noise at work

(3) Most days when there is a lot of noise at work

(4) Some days when there is a lot of noise at work

(5) Rarely

(6) Never

(25) Do you use hearing protection devices?

(1) Yes

(2) No

(26) If yes, how often do you use hearing protection devices?

(1) All the time at work

(2) Every day but only when there is a lot of noise at work

(3) Most days when there is a lot of noise at work

(4) Some days when there is a lot of noise at work

(5) Rarely

(6) Never

(27) If no, why not?

(1) They are uncomfortable

(2) I cannot hear warning signals when using them

(3) They fall out

(4) They do not work

(5) Other_____

(28) Do you think it is beneficial to use hearing protection devices?

(1) Yes

(2) No

(3) Don't know

(29) If yes, why? ***(Please explain)***

_____

_____

(30) If no, why not? ***(Please explain)***

_____

_____

(31) When you use hearing protection devices, do you use them for the whole shift?

(1) Always

(2) Sometimes

(3) Never

(32) If not always, why not?

(1) They are uncomfortable

(2) I cannot hear warning signals when using them

(3) They fall out

(4) They do not work

(5) Other_____

(33) Does anyone check whether you are wearing your hearing protection devices whilst at work?

(1) Yes

(2) No

(34) If yes, whom

(1) Your supervisor?

(2) Your co-workers?

(3) Other? ***Explain***_____

(35) Are hearing protection devices available to you whenever you want them?

(1) Yes

(2) No

(3) Don't know

(36) Are hearing protection devices available to you free of charge?

(1) Yes

(2) No

(3) Don't know

(37) Have you ever been refused hearing protection devices when you requested some?

(1) Yes

(2) No

(38) If yes, by whom

(1) Your supervisor?

(2) Your co-workers?

(3) Other? _____

(39) Are there specific times or areas where miners should use hearing protection devices at work? ***(Please explain)***

_____

(40) Are there specific times when miners should ***not*** use hearing protection devices at work? ***(Please explain)***

_____

(41) Do you consider deafness to be a status symbol among miners?

(1) Yes

(2) No

(42) Are there any reasons why miners may benefit from developing noise induced hearing loss? ***(Please Explain)***_____

_____

_____

(43) Whose responsibility is it to take care of miners hearing?

(1) Miners themselves

(2) Management

(3) Someone else ***Please explain***_____

(44) How important is hearing loss compared to other potential workplace problems such as injuries or illnesses?

(1) Hearing loss is more important

(2) Other issues are more important

(3) They are all equally important

(45) How would you prefer to be informed about hearing loss and hearing protection devices?

(1) Personally in large groups of more than 20 people

(2) Personally in small groups of less than 20 people

(3) Personally on a one on one basis

(4) Other means such as during computer assisted training, videos, etc.

(46) Who would you prefer informs you about hearing loss and hearing protection devices?

(1) Occupational Health staff

(2) Clinic or hospital staff

(3) Safety staff

(4) Training staff

(5) Direct supervisor

(6) Other_____

(47) Do you think anything can be done to influence the use of hearing protection devices among miners?

(1) Yes

(2) No

(3) Don't know

(48) Please explain your answer _____

_____

Interviewer, was the interviewee wearing hearing protection devices in the workplace prior to participation in the questionnaire?

(1) Yes

(2) No

(3) Yes, but used incorrectly

THANK YOU FOR YOUR COOPERATION AND YOUR TIME.

APPENDIX B - Subject Information Form for Participants

Dear Worker,

Hello, my name is …… I am here to invite you to participate in a study at this mine. The Study aims to better understand noise induced hearing loss in underground gold miners by investigating the use of hearing protection devices, and the knowledge, attitudes and practice regarding noise induced hearing loss and hearing protection devices in underground gold miners.

The method of study will include the following:

- Trained interviewers will conduct interviews
- Randomly selected participants who consent to take part in the study will answer questionnaires anonymously and be observed for the use of hearing protection

The results of the study will be anonymous i.e. not linked to the participant. This is because all written documents regarding you will not carry your name and therefore the answers on the questionnaire cannot be traced back to you.

Participation in this study is voluntary and you are free to refuse to participate or to withdraw your consent and discontinue participation at any time. Such refusal or discontinuance will not affect your status or benefits as an employee. Participation in the study will take about ten minutes. This time has been negotiated with the mine so that it is considered as working time. Findings and results of the study will be made available to unions and associations, mine management, full-time health and safety representatives and Occupational Health staff at this mine, who will then provide feedback to employees at this mine. This study will be beneficial to you and your co-workers in that feedback will be used to strengthen current hearing conservation programmes. Further information will be available to individuals at the Occupational Health center on this mine, upon request.

If you agree to participate in the study, please answer the questions as honestly as you can. Your opinions are very important, so feel free to express them. At no stage will the identities of any participants be recorded or divulged to anyone.

I have fully explained the procedures, identifying those which are investigational, and have explained their purpose. I have asked whether or not any questions have arisen regarding the procedures and have answered the questions to the best of my ability.

Date _____ Researcher _____

Date _____ Participant _____ OR Thumb print _____

APPENDIX C - Consent Form for Individual Participants

In signing this consent, I agree to participate in this study by answering a questionnaire that will ask me about my knowledge, attitudes and practice regarding noise induced hearing loss and the use of hearing protection devices as well as be observed for my use of hearing protection devices at this moment in time. I understand that no samples or tests will be performed and that I am free to participate or not participate in this study. I have been fully informed as to the aim, objectives and procedures to be followed in this study.

Any information about me is confidential and cannot be traced back to me.
Questions that I have had regarding this study have been answered to my satisfaction and I understand that if I have any questions at any time they will be answered.
I am also free to withdraw from this study at any time and this will not influence my status and benefits as an employee.

Date _____ Researcher _____

Date _____ Participant _____ OR Thumb print _____

APPENDIX D – Comprehensive List of Recommendations

The mainstay of reducing NIHL remains the adoption of the hierarchy of controls stated in the MHSA (1996). This stipulates interventions in the following order of importance, as far as is reasonably practicable before progressing to the following intervention. This hierarchy comprises:

- Elimination of the (in this case noise) hazard at source
- Substitution of materials or processes which increase risk associated with the hazard with equivalents with no or lower risk
- Engineering controls to minimise the magnitude of exposure
- Administrative controls to minimise duration of exposure
- Provision of PPE to reduce personal exposure

Whilst this paper concentrates on the latter intervention it should be borne in mind that this PPE such as HPDs are really only the last resort and that all such interventions would be unnecessary had the preceding ones been successful. Hence any and all HPD interventions, however well intentioned they may be, are still only to be undertaken after the aforementioned ones and hence the boundaries of reasonable practicability should constantly be challenged and surpassed to eliminate or reduce the source of the hazardous exposure rather than attempt to mitigate the effects thereof.

That having been said, the topic of this research relates to an aspect of prevention of NIHL requiring the use of HPDs and therefore the following recommendations relate to findings around such use.

All such recommendations are aimed at increasing the appropriate use of HPDs through:

- Increasing uptake of usage of HPDs, and
- Removing barriers to access to such devices

The former requires addressing knowledge and awareness of the need to use HPDs in terms of quantity and quality of education material, and correct practices relating to such usage whilst the latter addresses issues around systems, processes and procedures. These recommendations thus address the reasons

for non usage amongst participants in this study in the context of the “individual” and “environmental” reasons for non usage of HPDs reported in the international literature (Patel et al 2001). Whilst there is significant overlap between the two aspects they are considered separately for the purpose of clarity.

1.1 Recommendations Relating to Increasing Usage

These recommendations are laid out in terms of the ‘what’, ‘when’, ‘where’, ‘how’ and ‘why’:

1.1.1 Review of the Current Programme (‘What’)

- Verify that all employees are indeed attending and successfully completing the training they are meant to be undergoing at initial induction and refresher induction annually thereafter
- Review of the induction programme relating to education on NIHL and HPD usage, with the following objectives:
    - Review of the curriculum in terms of quality and quantity of content and searching for improved ways of education and training with improved outcomes
    - Ensure that the following elements receive priority in the training curriculum:
        - Increase knowledge of the benefits of HPDs
        - Emphasise more relevant and practical issues around use rather than an academic approach
        - Train in the necessity for consistent and constant use whenever exposed to hazardous noise
        - Address possible language barriers in the training process
        - Include instruction on the correct method and habit of use of insertion, cleaning and storage of HPDs

- Educate workers that there are other noise hazards in the workplace over and above those they may know necessitating a need for consistent and continuous HPD usage
- Educate about insertion, cleaning and storage of HPDs and check on correct practice to improve effectiveness of HCP amongst those using devices
- Educate people about non occupational noise exposure and the potential thereof for causing NIHL

- Ensure consistency of training objectives both within the induction programme and across all groups of people who are training such as the supervisors, Occupational Health staff, medical staff and others. This promotes positive reinforcement of a consistent message
- Clearly indicate demarcated noise zones in order to improve awareness people are entering noise zones and therefore need to use HPDs
- Collaboration with organised labour – include unions and association and H&S committees in all initiatives to address NIHL

1.1.2 Method of Training ('How')

Whilst the current method of training using computer assisted modules researched and developed for this specific environment are popular amongst a large proportion of those interviewed, this is not true for the entire study sample, and therefore study population. Hence it comes as no surprise that 44% of respondents would prefer to be trained personally on a one on one basis and 13% would rather be trained personally in large groups. Hence it is recommended that the site:

- Offers personal training on a one on one basis to workers who would prefer this medium of instruction to the current computerised training
- Create a culture of checking on co-workers thereby departing from 'enforcement' and 'hands off' to personal empowerment and co-worker involvement. The aim should be to make use of HPDs 'the norm' and

getting people to take on the responsibility for checking on the use of HPDs by their co-workers in addition to themselves.

- Promote and incentivise the checking up of use HPDs by co-workers thereby promoting positive reinforcement of this behaviour
- Consider incentivising the use of HPDs through a performance based management system with an emphasis on team-based reward programmes for compliant teams
- Couple HPD usage with other healthy and safe behaviour initiatives
- Make more use of various methods of education such as billboards, placards, advertisements in the company newsletters and local radio stations to drive the message further

1.1.3 Consider Alternate Educators and Trainers ('Whom')

- Consider changing the 'primary' training from the current computerised system to a non computerised training programme
- Support 'primary' training initiatives with strong adjunctive training at the:
    - Occupational Health Centres (as desired by 24% of respondents),
    - Direct supervisors (as desired by 21% of respondents), and
    - Safety staff (as desired by 19% of respondents)
- Identify high risk or particularly susceptible individuals or groups such as those with early NIHL and counsel them about their risks and alternatives for preventing deterioration. This can be done at the Occupational Health Centres at periodical medical examination
- Use 'peer educators' (as are used in HIV counselling settings) to counsel workers about the risks of developing NIHL
- Consider using 'people living with NIHL' (similar to 'people living with HIV and AIDS') as part of education to drive home the relevance of this condition

- Get unions and associations and Health and safety committees at the operation to (ideally) drive or (at least) support all initiatives, thereby making this a multi disciplinary and multilateral approach

1.1.4 'When and Where'

Following the principle of "prevention is better than cure" use every available relevant opportunity to educate people and improve awareness around NIHL. These include but are not limited to:

- Every visit to the workplace Occupational Health facilities
- Every visit to the workplace medical facilities
- Union and Associations' offices

1.2 Recommendations Relating to Removing Barriers to Usage

1.2.1 Removal of Actual Barriers to Access through:

- Ensuring that all workers have access to HPD whenever they are exposed to noise in the workplace
- Ensuring a constant and consistent supply of HPDs to noise-exposed workers
- Ensuring that these HPDs are available free of charge
- Offering a range of HPD types (or at least a few types) and offer custom made devices to those who cannot find comfortable ones or for those in whom these fall out. Coupled with this, instructing and demonstrating the correct methods of insertion, cleaning and storage (where applicable) of these devices is important.
- Increasing or improving the distribution network where applicable taking into account ease of accessibility and uninterrupted supply

1.2.2 Removal of Perceived Barriers to Access through:

- Making workers aware of the sources from which these devices may freely be obtained
- Putting in place a system whereby workers can report the unavailability of HPDs
- Putting into place a system whereby management attends to such reports in a quick, effective and decisive manner

All of the above need to be based on the following health promotion principles:

- Make the correct practice, the easy practice
- Provide large scale awareness
- Provide personal (one on one) education where necessary
- Provide an environment of positive reinforcement of healthy behaviour including the use of HPDs