Knowledge and Attitudes of a Group of South African Mine Workers Towards Noise Induced Hearing Loss and the Use of Hearing Protective Devices

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ABSTRACT

The study aimed to explore the knowledge and attitudes of a group of mine workers regarding noise induced hearing loss and the use of hearing protective devices. These aims were investigated via a questionnaire administered in a group setting to 55 underground mine workers. The main finding that emerged from the study was that respondents were poorly informed regarding the fact that noise was a health hazard. Furthermore, the knowledge that respondents did possess, appeared to have been derived from the personal experience of working in noisy environments for many years, rather than from educational input. Contrary to expectations, respondents did not view deafness as a status symbol but rather as a negative attribute. Consequently, they were motivated to protect themselves from hearing impairment and to be educated about hearing and the effects of noise. The mine workers complained about discomfort when wearing hearing protective devices as well as feelings of insecurity due to inhibition of communication and the inability to hear warning signals. For these reasons, noise protection was mainly worn in situations perceived as noisy by workers themselves. These results are discussed in terms of their implications for the clinical practice of audiology; hearing conservation in the mining industry; further research; and the training and education of speech-language pathologists and audiologists.

OPSOMMING

Daar is met hierdie studie gepoog om die kennis en standpunte van 'n groep mynwerkers aangaande gehoorverlies, veroorsaak deur geraas, en die gebruik van gehoorbeskermende apparate te ontgin. Die doelwit is ondersoek deur middel van 'n vraelys wat aan 'n groep van 55 ondergrondse mynwerkers uitgedeel is. Die vernaamste bevinding wat deur die studie opgelewer is, was dat proefpersone nie voldoende ingelig is aangaande die feit dat geraas 'n gesondheidsrisiko inhou nie. Verder is die kennis waaroor proefpersone beskik het blykbaar verkry uit persoonlike ondervinding van jarelange werk in geraasomgewings eerder as deur middel van opvoedkundige insette. In teenstelling met verwagtinge het proefpersone doofheid nie as statussimbool beskou nie, maar veel meer as 'n negatiewe eienskap. Hulle is gevolglik gemotiveer om hulself te beskerm teen gehoorbeskadiging en om ingelig te word betreffende gehoor en die gevolge van geraas. Die mynwerkers het gekla oor ongerief wanneer hulle gehoorbeskermende apparate moes dra en ook oor gevoelens van onsekerheid as gevolg van inhibisie van kommunikasie en die onvermoë om waarskuwingseine te hoor. Om hierdie redes is geraasbeskerming hoofsaaklik gebruik in situasies wat deur die werkers self as raserig beskou is. Hierdie resultate is bespreek in die lig van implikasies vir die kliniese praktyk van oudiologie; gehoorbeskerming in die mynnywerheid; verdere navorsing; en die opleiding en opvoeding van spraaktaalterapeute en oudioloë.

Hearing loss due to occupational noise exposure has been estimated to be the most prevalent industrial disease (Sataloff & Sataloff, 1987). The physiological and psychological effects of noise on humans have been recognised for centuries (Miller & Silverman, 1984). In fact, the first known reference to noise induced hearing loss (NIHL) was found in the medical literature of the sixteenth century (Howse, 1987). In addition, a steady increase in the intensity and prevalence of noise in both living and working conditions has been noted since the Industrial Revolution (Sataloff & Sataloff, 1987). Moreover, as modern technology has become more sophisticated, greater recognition of the effects of noise on hearing has occurred. "Noise adversely affects the quality of life and strong links exist between noise levels and accident rates. Recognition of this causal relationship has prompted legislation which, in turn, has been instrumental in the design and institution of hearing conservation programmes" (Kielblock, 1986, p.2).

Legislative Acts which have either directly or indirectly affected industrial hearing conservation programmes include the Factories, Machinery and Building Work Act (1941), the Machinery and Occupational Safety Act (1983) and the Mines and Works Act (1956) which was amended in 1964 and 1989 and amalgamated in 1991 to form the Minerals Act No. 50 of 1991. Ac-

cording to a notice in the Star newspaper, May 1994, a Commission of Inquiry into Safety and Health in the Mining Industry was being planned. The purpose of this inquiry was to investigate all aspects of the legal regulation of health and safety in the mining industry as defined in the Minerals Act, No. 50 of 1991; and to make recommendations to the State President on improvements to the existing regulations. This Commission of Inquiry formed part of the National Health Plan for South Africa (1994) formulated by the African National Congress (ANC).

Against this historical and legislative backdrop, noise has been defined as "any unwanted auditory, electric or other signal, a signal that interferes with the detection and discrimination of sound and sound having aperiodic waveform" (Sheeley, 1985, p.1079). "Noise is capable of producing a hearing loss in two ways: The hearing loss could result from acoustic trauma (e.g., an explosion), or it could be produced from chronic exposure to noise" (Miller & Silverman, 1984, p.101). Noise induced hearing loss typically begins in the high frequencies (especially 4000 Hz) and progresses to involve speech frequencies with continuing exposure (Jackler & Kaplan, 1994). Effects of noise on hearing may be divided generally into three categories: temporary threshold shift, permanent threshold shift and acoustic trauma (Miller & Silverman, 1984; Guignard, 1973 in Melnick, 1985). Temporary threshold shift (TTS) refers to a short-term elevation in the threshold of hearing which recovers gradually following the noise exposure. Permanent threshold shifts (PTSs) are those hearing changes which persist. PTSs which result from acoustic trauma or a single encounter with very destructive noise do exist but are relatively uncommon. More frequently, hearing loss produced by the effects of noise exposure is a result of accumulation of noise exposure which is repeated on a daily basis over a period of years.

Studies conducted by the Chamber of Mines Research Organisation (COMRO) clearly show that noise induced hearing loss occurs frequently in numerous instances due to workers' excessive exposure to noise. These studies were first started by COMRO in 1974 and the first industry wide studies followed in 1979 (Leger, 1985). According to South African Labour Statistics, at the end of 1993 there were 676,380 people employed in the mining and quarrying industry. It is difficult to calculate the number of these workers exposed to noise. It has, however, been pointed out by the National Institute of Occupational Safety and Health (NIOSH) that the number of workers exposed to noise in the mining industry far exceeds the number exposed to noise in the majority of other industries (Kielblock, Van Rensburg, Frans & Marx, 1991).

For this reason, formal hearing conservation programmes have been introduced in the mining industry. The fundamental objective of any hearing conservation programme (HCP) is to protect workers from suffering permanent hearing impairment as a result of excessive exposure to noise at their place of work (Miller & Silverman, 1984; Kielblock, 1986; Sataloff & Sataloff, 1987).

Personal protection by means of hearing protective devices (ear-muffs or insertable plugs) is the most common form of hearing conservation in the South African mining industry to date (Kielblock, 1986; Shearer, 1992; Kielblock & Van Rensburg, 1988). In order for hearing conservation programmes to be effective, it is therefore imperative that those at risk wear appropriate hearing protection correctly and consistently.

As early as 1961 Maas (cited in Newby & Popelka, 1985) reported on a study by an insurance company in Wisconsin, which found that only 22.5% of the 1,148 plants polled, indicated success in encouraging workers to accept ear protectors for a period of six months or more. Reasons for not utilizing ear protection included discomfort, headaches, interference with hearing, and getting used to noise so that it was not regarded as bothersome. By the next decade, the situation did not seem to have improved greatly as Mass (1975) revealed a failure rate of more than 50% of hearing conservation programmes conducted in the United States. One of the primary reasons for this failure rate appeared to be the fact that workers did not perceive noise as a health hazard. Another feature of the resistance to avoiding noise exposure stems from anecdotal evidence on the "macho" image which some men feel the need to display. Wearing ear protectors is perceived as a sign of weakness (Lipscomb, 1988). More recently, Kielblock (personal communication, 1994) hypothesized that a possible reason for South African mine worker's reluctance to wear hearing protective devices might be related to the positive status of mine workers. As noise is part of the mine workers' job, he suggested that noise induced hearing loss represents an emblem of pride for the mine worker in that it provides proof that he has worked on the mines.

Stewart (1988) highlights a further factor which is likely to influence mine workers' attitudes towards the use of hearing protective devices . He explains that the sound levels of all sources of noise to which workers are exposed, fall well below the pain threshold which is about 140dBA. Furthermore, in view of the fact that typical noise induced hearing loss does not interfere with speech discrimination, at least not during the early stages, the noise hazard is usually not perceived as real.

Kielblock & Van Rensburg (1988) studied a group of 480 novices and returners to the South African mining industry in order to explore the relationship between workers' perceptions of noise as a health hazard and their willingness or reluctance to wear hearing protectors. They found that more than 80% of their respondents did not perceive noise as a 'problem' in their jobs, while the most experienced workers were capable of identifying the most noisy work categories. Permanent hearing loss, as a sequel to prolonged exposure to noise, was regarded as a health hazard by only 16% of the respondents. The need for hearing protection in noise was recognised in 65% of cases, but 47% of respondents were averse to protecting their own hearing, since they felt that they would not be able to hear anything while wearing hearing protectors. The attitude of the mine workers towards noise as a health hazard thus appeared to contribute to the high failure rate of the hearing conservation programmes. Kielblock & Van Rensburg (1988) concluded that invariably the value of education (as a means of influencing attitudes) is under-estimated. They emphasize that the challenge to education is to convince employees that noise which is not painful can still lead to hearing loss which is not apparent at first. In other words, employees should be educated to regard noise as a hazard similar to more obvious hazards such as heat,

electricity and falls of ground.

Despite the important findings yielded by this study, it must be borne in mind that the researchers asked respondents only three questions in order to minimise disruptions to work routine and productivity on the mine. The present research project endeavoured to extend and build on Kielblock & Van Rensburg's pioneering research efforts by surveying a broader range of knowledge and attitudes held by mine workers, towards noise induced hearing loss and the use of hearing protective devices.

The opportunity to conduct the study, was provided by a diamond mine situated in the Northern Transvaal. According to the 1993 Annual Report, the mine in question retained a Five Star safety grading in 1993, but safety performance deteriorated. The progressive disabling-injury incidence rate rose from 0,32 per 200,000 man hours worked in 1992, to 1,33 per 200,000 man hours worked in 1993. A revised safety management programme was formulated and is currently being implemented on the mine in order to reverse this adverse trend. The Loss-Control Co-ordinator in charge of implementing the programme expressed the view that the research project would fulfil a vital need by providing important information which could hopefully be embedded in the revised safety management programme.

Furthermore, before the mine management embarked on a time-consuming and costly educational programme with their large workforce, it seemed advisable to first obtain more facts on workers' attitudes. It was hoped that a survey of mine workers' knowledge and attitudes towards noise-induced hearing loss and the use of hearing protective devices, would not only improve existing guidelines for hearing conservation programmes with this section of the population, but also contribute knowledge and understanding to a relatively neglected research area.

Moreover, the central focus of health policy in South Africa is currently on primary health care as articulated in the African National Congress's publication: A National Health Plan for South Africa (1994). Hearing conservation, as a form of preventive medicine, falls within the ambit of primary health care, thus underscoring the relevance and appropriateness of the present study to the South African context. Moreover, the fact that a Commission of Inquiry into Safety and Health in the Mining Industry, was being held at the time the research project was conducted, further underlined the timeliness of the study.

METHODOLOGY

AIMS OF STUDY

1. To investigate mine workers' knowledge of noise as a health hazard.
2. To explore the attitudes of these mine workers towards hearing loss; and
3. To examine their attitudes towards wearing hearing protective devices.

SUBJECTS

Criteria for Selection:

1) Subjects were required to be males between the ages of 24 and 45 years. This criterion was adopted because writers such as Jerger & Jerger (1981) maintain that auditory sensitivity of subjects in this age range is unlikely to have been affected by exposure to noise, use of ototoxic drugs or to degenerative effects associated with age. However, it is recognised that this assumption is open to question.
2) Subjects were required to present with normal hearing. "According to the law employees working in noise levels above 85dB must have hearing tests at least once per year" (Noise: A Safety Steward's Manual, 1991, p.49). The advantages of this procedure is that it allows the workers to be transferred to quieter jobs before their hearing is significantly affected. The disadvantage is that managers may transfer workers to jobs with lower remuneration or dismiss workers on the pretext that they must be repatriated for medical reasons. In view of these possible consequences of hearing impairment, persons who had sustained a hearing loss were excluded from the study as it was felt that this factor might have influenced their employment experiences and consequently biased their responses to the questionnaire.
3) The third subject selection criterion was literacy i.e., the ability to read and write English, so as to prevent incorrect information being collected due to a lack of understanding of the research instrument.
4) The final criterion was that all subjects were required to be working underground, so that they would be exposed to similar environmental conditions, altered by type of work only.

Subject Sample

After obtaining permission from the management of the mine as well as the co-operation of the National Union of Mine Workers, 55 miners employed at the mine in question, were recruited for participation in the study. Assistance was sought from the medical and loss control specialists employed at the mine to ensure that all subjects met the selection criteria.

A non-probability, convenience sample was used. According to Bless & Achola (1990 p.75) this sampling procedure consists of taking all cases on hand until the sample reaches the desired size. For practical reasons as well as safety considerations, the subject sample comprised all workers who belonged to the same shift and worked on the same level underground on the day on which the study was conducted. The level chosen by the mine management accommodated 60 persons working in different categories e.g., drillers, operators, mechanics and helpers. Of these 60 persons, 55 met the subject selection criteria. Unfortunately, for reasons of confidentiality, it was not possible to obtain information from the mine regarding the levels of noise to which these different categories of workers were exposed.

Description of Subjects

The sample comprised 55 male mine workers. The ages ranged from 25 to 45 years with a mean age of 36.6 years. The home languages of the subjects were: Sotho 47.3%, Zulu 5.5%, Pedi 14.5%, Shangaan 1.8%, Afrikaans 16.4%, English 1.8% and Xhosa 10.9% with 1.8% unknown. Extent of work experience ranged from 3 years to 28 years with a mean of 13 years and 8 months. The categories of jobs worked included: help-

ers 50.9%, machine drillers 7.3%, operators 12.7% and mechanics 24.1%. While 18.2% of the respondents mentioned that they had previously suffered from external or middle ear pathologies e.g., otitis media, the vast majority, namely 81.8%, had experienced no problems with their ears. All subjects had been audiometrically assessed as having normal hearing.

RESEARCH DESIGN

In order to investigate the aims of the study, a survey research design was employed. In terms of the size of the mining population, its demographic spread and restrictions of time and resources, the use of a short questionnaire, personally administered, in a group setting to a sample of mine workers, was believed to be the most appropriate methodological tool for this study.

DESCRIPTION OF THE QUESTIONNAIRE

A 6-page questionnaire comprising 27 questions was constructed which could be completed in 15-20 minutes. The instrument was drafted in English and a speaker of Fanakalo was available for the benefit of respondents who came from diverse language backgrounds.

The introductory letter provided assurance of confidentiality and anonymity and explained the purpose of the questionnaire. According to Bailey (1987) these factors often determine whether or not respondents co-operate in filling in the questionnaire honestly and completely. Included with the covering letter was an Informed Consent Statement which complied with the guidelines laid down by the Committee for Research on Human subjects, University of the Witwatersrand.

The questionnaire was made up of the following sections:

A) Demographic questions; and
B) Knowledge and Attitudinal questions that examined:
   i) Knowledge of noise induced hearing loss and the use of hearing protective devices.
   ii) Attitudes towards noise induced hearing loss and the use of hearing protective devices; and
   iii) Perceptions of the extent of service provided by the mines in the area of hearing conservation.

These two sections are described separately as follows:

Demographic Information

The aim of the first eight questions was to obtain a socio-demographic profile of the respondents by soliciting biographical information on age, home language, type of work engaged in, and duration of work experience, as well as to identify anyone who had experienced ear or hearing problems in the past.

Questions which investigated Knowledge of and Attitudes Towards Noise Induced Hearing Loss, Hearing Conservation and Services

The present study aimed to identify the knowledge and attitudes of mine workers towards noise induced hearing loss and the use of hearing protective devices. In view of the fact that English was the second language of the respondents targeted in the study, the majority of questions were formulated in a closed-ended format to facilitate ease of completion.

The rationale for inclusion of the various items in the questionnaire was based on guidelines laid down by the National Union of Mine Workers, relevant legislation, as well as the literature on hearing conservation. According to "Noise: The Safety Steward's Manual" of the National Union of Mine Workers (NUM) (1991), the Minerals Act states that if it is not possible to bring the noise levels down to below 85dB, management is obliged to implement a hearing conservation programme. The first step involved in achieving this goal is the requirement that management signpost all noisy areas. Question 1 therefore endeavoured to ascertain whether respondents had previously observed these noise warning signs. Questions 2, 3 and 4 investigated workers' knowledge and perceptions of noise in their working environments and its effects. These questions related to findings in the literature that workers apparently lack information and are uneducated about noise and its effects on hearing (Kielblock & Van Rensburg, 1988; Leger, 1985; Shearer, 1992; Noise: The Safety Steward's Manual, 1991).

Management is further obliged to carry out hearing tests on every worker annually. If the noise level exceeds 105dB, hearing tests must be conducted every six months. Questions 5 and 6 therefore aimed at obtaining information on the frequency of hearing tests conducted on respondents. The publication "Noise: The Safety Steward's Manual" (1991, p.30) states that "Workers don't know the results of their hearing tests." Hence question 7 probed whether results of hearing tests had been explained to the mine workers.

Question 8 then explored whether respondents had been given information on the effects of noise on hearing. Question 9 explored respondents' motivation to learn about noise and hearing, and question 10 investigated the manner in which respondents wished to obtain information on these topics.

Question 11 aimed to investigate respondents' attitudes towards a hearing loss. Kielblock (personal communication, 1994) suggested that one of the weaknesses of hearing conservation programmes was respondents' lack of education. He also hypothesised that they perceived a hearing loss as a sign that they were mine workers and therefore a symbol of pride.

Management, is expected, according to the SABS 083-1983 Code of Practice for the Measurement and Assessment of Occupational noise for hearing Conservation Purposes, to train workers on how to use hearing protection. Hence question 12 inquired whether respondents wore any hearing protective devices. Questions 13 and 14 focused on reasons for use or non-use of hearing protectors and question 16 attempted to ascertain whether training had been given in the use, storage, cleaning and replacement of such devices.

It is suggested in "Noise: The Safety Steward's Manual" (1991) that management give each worker the opportunity to try out a number of different types of hearing protection. Question 15 therefore endeavoured to ascertain whether workers had in fact been given a choice of hearing protective devices.

Questions 17 and 19 investigated respondents' attitudes towards hearing conservation programmes and were based on the hypothesis that if the mine workers viewed hearing loss as a positive attribute (Kielblock, personal communication, 1994) or if they were uneducated about the connection between noise and hearing loss (Kielblock & Van Rensburg, 1988; Shearer, 1992; Leger, 1985) then they would most likely view a hearing conservation programme as being unnecessary and hence not request that one be started on the mine. Question 18 enquired if the mine already had a hearing conservation programme in place.

The final item, that is, question 20, used an open-ended format which allowed respondents the opportunity to express any other views or comments on the topic under discussion.

RESEARCH PROTOCOL

Submission of Questionnaire to the Human Ethics Research Committee

In accordance with the Code of Ethics for Research on Human Subjects (University of the Witwatersrand), the questionnaire was submitted to the relevant University Committee to ensure that informants' physical, social and psychological welfare was protected and their dignity and privacy respected.

Pilot Study

The adequacy of the research instrument and the practical possibilities of carrying out the project were assessed in a pilot study. The questionnaire was submitted to a member of the mine management as well as a NUM official for approval before the pilot study was carried out. Four underground mine workers from the mine were the subjects in the pilot study. These men were excluded as subjects in the field study.

Although an official from the mine had informed the researcher that all the mine workers were able to read and write English, the pilot study revealed that different workers demonstrated different levels of understanding. It was therefore decided to utilize the services of a Fanakalo interpreter employed at the mine in order to enhance understanding of the questionnaire by respondents.

The Field Study

The study was conducted in a group setting underground in the workshop area. The researcher was present to answer any queries and two speakers of Fanakalo were available if subjects needed clarification or translation of any questions or words. Both translators had been briefed previously on the need to adopt a neutral, objective stance and to keep as close as possible to the original phrasing of questions so as to avoid biasing respondents' answers. Singleton, Straits & Straits (1993, p.262) state that "interviewers must be trained to be sensitive to the way in which they may wittingly or unwittingly affect their interviewees' responses".

Data Analysis

Data were analysed using descriptive statistics derived from the SAS computer package, and presented in the form of tables and bar charts. Statistical procedures adopted were univariate analyses, which provided frequency distributions, means and ranges. Cross-tabulations of certain variables were also carried out, as well as Chi-square analyses to determine differences between sub-groups on certain items. Open-ended questions were analysed qualitatively according to themes expressed by the respondents.

RESULTS AND DISCUSSION

Results of the study are presented according to the order in which items appeared in Section B of the questionnaire[1].

RECOGNITION OF THE NOISE WARNING SIGN

The mine workers' knowledge was explored by eliciting information on the percentage of respondents who recognised the noise warning sign, as well as the proportion who understood what the sign meant. The vast majority of respondents i.e., 53 (96.4%) of the 55 persons in the sample recognised the sign, while a similar proportion i.e., 52 (94.5%) understood the meaning of the sign. These results indicated that the notices at the shaft head, advising persons to wear hearing protectors when entering a noise zone, as well as the appropriate noise warning symbols, prominently displayed at all entrances and exits of noise zones i.e., areas where noise exposure was greater than 85dBHL, were effective in that the mine workers had seen them and understood why they had been erected. The implication of these findings is that the mine was carrying out the guidelines on noise warning signs laid down by the SABS and that these notices were being effectively seen and understood.

RESPONDENTS WHO FELT THEY WORKED IN NOISY CONDITIONS

The majority of respondents i.e., 42 (76.4%) felt they worked in a noisy place. A survey conducted by the Chamber of Mines suggests that the majority of underground day shift workers are exposed to an equivalent noise level of 100dBA or more (Van Rensburg, Schutte, Strydom, Jooste & Schoeman, 1980). The results obtained from the present study appeared to validate the statement made by the Chamber of Mines. According to SABS 083-1970, the hearing of 120 out of every 1000 workers will be impaired within five years if exposed to noise levels of this intensity. These figures imply that unless the hearing conservation programmes are successful or there is greater noise control engineering, there is likely to be a large number of workers presenting with hearing losses and an extensive hearing impairment liability for mine management in the form of compensation claims.

[1] Copies of the questionnaire are available from the second author, Dept. of Speech Pathology and Audiology, University of the Witwatersrand, P.O. Wits, South Africa, 2050.

RESPONDENTS WHO FELT THAT WORKING IN NOISE AFFECTED HEARING

A total of 52 (94.5%) of the respondents felt that working in noise affected hearing. These results illustrate that the workers were aware of the dangers of noise. However, on further questioning to ascertain why the workers thought that noise affected hearing, many miners stated that they did not know the reason but realised that noise influenced hearing due to personal experience. Some of the statements furnished by respondents which highlighted this point included the following:

- "Because I can feel it afterwards."
- "The noise hurts my ears and I can't hear my friends on the way back from work."
- "Self-experience."

Another common response was that when working in noise, the noise blocked out all other sounds including the sounds of people talking. These findings suggested that much of the workers' knowledge appeared to be derived from the personal experience of working in a noisy environment. This is understandable if one considers that the mean number of years worked on the mine, was 13 years 8 months. The majority of these workers felt that they worked in a noisy environment and SABS 083-1970 states that noise levels of 100 dBA can cause 120 out of every 1000 workers to become hearing impaired within five years. The emphasis on prevention in the new government health care policy (A National Health Plan for South Africa, 1994, p.19) would appear to underscore the need for workers to be educated about the dangers of noise rather than learn about noise through physically experiencing its effects. In this respect professionals who have been trained in the field of audiology could fulfil a vital educational role by supplementing the valuable services currently provided by personnel from other disciplines involved with hearing conservation on the mines.

RESPONDENTS' PERCEPTIONS OF CHANGES IN THEIR HEARING STATUS SINCE WORKING ON THE MINE

When respondents were asked about the stability of their hearing, 34 (61.8%) stated that they felt their hearing had remained the same, while 21 (38.2%) perceived their hearing to have deteriorated. This finding suggests that in 38.2% of the cases the hearing protection was either not effective or not being used. Information on perceived hearing status was cross-tabulated with data regarding the use of hearing protective devices while working, and the results depicted in Table 1. The findings show that 22 (40%) of the respondents who wore their hearing devices compared with the 12 (21.9%) who did not wear these devices while working perceived their hearing to have remained the same, while 19 (34.5%) of respondents who wore their hearing protective devices and the 2 (3.6%) who did not use these devices perceived their hearing to have deteriorated. The findings imply that although 40% of respondents were wearing their hearing protection and finding their hearing to be the same, 34.5% stated that they were wearing their hearing protection and the hearing protection devices were not efficacious, i.e., conserving their hearing. A Chi-squared analysis indicated significant differences between these sub-groups ($X^2 1=4,543$; $p < 0.05$). However, the data only represent workers' *perceptions* of their hearing status. In order to obtain more scientific data, one would have to correlate respondents' perceptions with audiometric test results.

Table 1. Respondents' perceptions of their hearing status since working on the mines. Cross tabulated with the use of hearing protective devices, while working

	Yes	No
Remained the same	40,0%	12,9%
Deteriorated	34,5%	3,6%
Total	74,5%	16,5%

REGULARITY OF HEARING TESTS

All the respondents reported that their hearing was tested annually, prior to going on vacation. This finding demonstrates that the regulations laid down in the SABS 083-1983 were being effectively implemented at the mine in question.

EXPLANATION OF RESULTS

Table 2 shows the percentage of mine workers who stated that the results of their hearing tests had been explained to them. The majority of workers namely, 38 (69.1%) reported that they had not had the results explained to them. These data were cross-tabulated with the workers' home language. It is of interest to note that the majority of respondents who had had the results of their hearing test explained to them were Afrikaans first language speakers. This finding may indicate that due to language barriers the results of the hearing tests are

Table 2. Respondents who had/did not have their hearing test results explained to them, cross tabulated with their first language

	Yes	No	Unknown
Sotho	5,5%	40,1%	1,8%
Pedi	3,6%	10,9%	0
Xhosa	1,8%	9,1%	0
Afrikaans	12,8%	3,6%	0
English	1,8%	0	0
Shangaan	0	1,8%	0
Zulu	1,8%	1,8%	1,8%
Unknown	0	1,8%	0
Total %	27,3%	69,1%	3,6%

not explained to all workers. One possible way of dealing with language barriers could be for translators to be available to explain the results of the hearing tests to the workers. Indeed, the effective use of a system of interpreters and translators could play a vital role in ensuring the success of hearing conservation programmes. Such a system could firstly, educate the workers about their individual hearing as well as about hearing in general; and secondly, inform workers, so as to empower them to make their own decisions about their hearing i.e., whether they needed to be transferred to a quieter job or whether they should choose a different type of hearing protection device. As Kielblock (1986) states: "The success of any hearing conservation programme hinges primarily on education and personal relevance." The explanation of the workers' hearing test results could go a long way towards fulfilling both these criteria.

RESPONDENTS WHO HAD BEEN EDUCATED ABOUT THE EFFECTS OF NOISE ON HEARING

Fig 1 indicates the percentage of respondents who had been advised about the effects of noise on hearing. A total of 31 (56.4%), reported being informed; however, 24 (43.6%) were not informed. This percentage suggests that many workers were not receiving sufficient education/ information. Kielblock (1986) maintains that this lack of education is the reason why programmes fail. It would therefore appear to be vitally important to enhance the educational side of hearing conservation programmes.

RESPONDENTS WHO REQUESTED INFORMATION ABOUT NOISE AND HEARING

Fig. 2 shows that a large number of respondents namely 34 (61.8%) indicated a desire to learn more about noise and hearing. This finding may be due to the results obtained from question 3 i.e., that respondents' knowledge about noise and hearing had been derived primarily through personal experience rather than educational input. It would therefore be interesting to pose this same question to novice mine workers with limited work experience and compare results with those obtained from miners with longer work histories.

MEDIUM OF INFORMATION REQUESTED FOR LEARNING ABOUT THE EFFECTS OF NOISE ON HEARING

This item probed the manner in which respondents wished to be informed about the effects of noise on hearing. The majority of respondents indicated a preference for video, while the remaining respondents were equally divided between a personal talk or a group talk. These results provide important information on how to supplement existing hearing conservation programmes with additional input that will reach the workers and, hopefully, make the programmes more effective. Through the medium of film/video, group talks and personal talks, and with the help of professionals in the field of noise and hearing, it is possible to educate and motivate respondents so as to improve the chances of hearing conservation programmes being successfully implemented.

ATTITUDES TOWARDS THE VIEW THAT DEAFNESS IS A POSITIVE STATUS SYMBOL FOR MINE WORKERS

Fig 3 demonstrates that the majority of respondents either disagreed or strongly disagreed with the statement that deafness is a positive status symbol for mine workers. There was only 1 (1.9%) respondent who strongly agreed and 2 (3.7%) who responded neutrally. This finding implies that the majority of the mine workers in the sample did not feel that deafness was a positive status symbol. This result appears to refute the idea expressed by Kielblock to the researcher personally, that part of the challenge to a hearing conservation programme was the positive attitude of mine workers towards a hearing loss. However, the present research

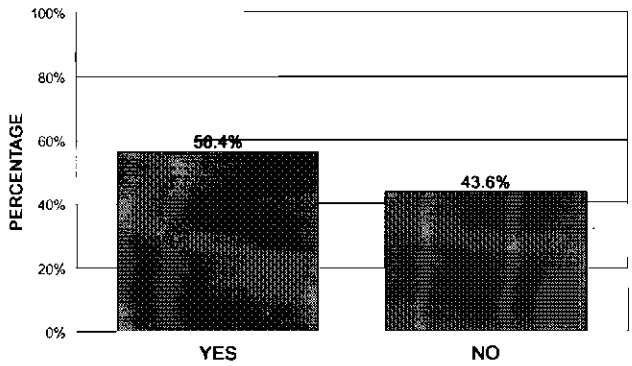

Figure 1. Respondents who had or had not been told about the effects of noise on hearing (N=55)

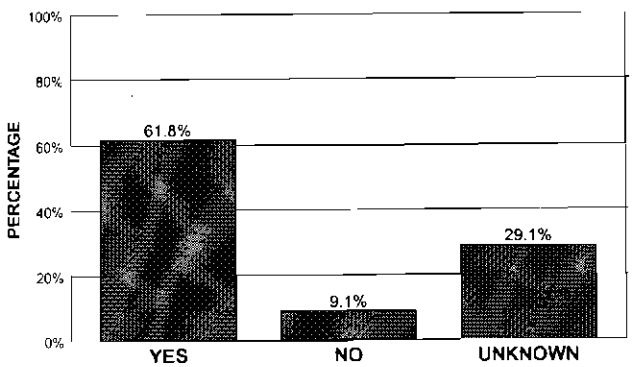

Figure 2. Respondents who requested information about noise and hearing. (N=55)

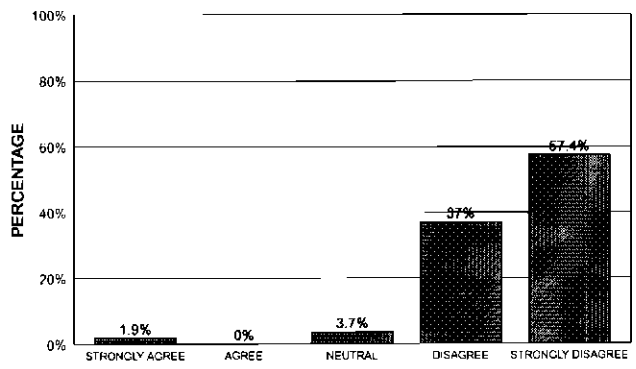

Figure 3. Attitudes towards the view that deafness is a positive status symbol for mine workers. (N=55)

project was conducted on a relatively small convenience sample which precludes generalisation of the results to the broader population of mine workers. It is therefore suggested that the research be replicated on a larger, more representative sample and results compared.

USE OF HEARING PROTECTIVE DEVICES WHILE WORKING

The majority of mine workers i.e., 41 (74.5%) stated that they used hearing protection while working.

REASONS FOR THE USE/NON-USE OF HEARING PROTECTION WHILE WORKING

Mine workers' attitudes were examined by eliciting explanations for wearing or not wearing their hearing protective devices. Qualitative responses included the following:

- "To protect the ear; to prevent deafness."
- "Only when they are compulsory, when they are not compulsory noise can't be bad for you."
- "Only when in loud noise."
- "Depends where one is working, the noise is not very bad everywhere."

From the above statements it appears that the majority of respondents wore hearing protection in noise that they considered to be dangerous for them. However, one is not sure whether or not respondents' definitions of loud noise meant noise greater than 85 dBA as recommended by the SABS. This implies that workers may have had hearing protection available to them but may still have been exposing themselves to harmful noise due to incorrect judgement of the noisy situation. The only way to prevent this phenomenon from occurring seems to be via education. It would seem that workers need to be informed about what noise level is harmful and given an example/model of harmful noise intensity which they can use to assess whether or not they are in a hazardous noise zone. Reasons for not wearing hearing protective devices while working, included the following:

- "Inhibits communication."
- "Can't hear warning signals."
- "Uncomfortable."
- "Causes skin irritation."
- "Machines only come sometimes, so not so noisy."

These examples indicate that the majority of reasons for not wearing hearing protection centred firstly, around the lack of comfort and secondly, the inability to "hear the hanging talk". With regard to the first aspect, comfort is one of the issues constantly addressed by employers, employees and manufacturers of hearing protective devices. It is also indirectly addressed in the SABS 083-1983 Code of Practice which states that workers must be provided with a choice of hearing protective devices. With regard to the second aspect, Jones (1994, p.29) explains that "hanging talk is referred to by mine workers as a sort of primordial whisper as tiny fractures spread rapidly through the ground. The only other natural alarm is the scuttling of rats as they abandon miners to their fate." Similar concerns have been found among workers who have to wear hearing protection world-wide (Sataloff & Sataloff, 1987; Miller & Silverman, 1984; Kielblock, 1986; Leger, 1985). The view that hearing protective devices inhibit communication is challenged and defended in various studies. Kryteri, 1946, in Leger (1985) found slight improvements in signal and speech intelligibility from wearing hearing protection. Schroder, Van Rensburg, Schutte & Strydom (1980), also endorse the above view. Endruweit & Hach (1977), state that hearing protection improves speech communication in noisy environments; however, adaption is necessary and varies from person to person. Kielblock (1986) explains that with hearing protection one hears better, but differently. Wilkins & Martin (1982) challenge some of these assumptions by saying that wearing hearing protection did not have any major effect on recognition of artificial warning signals such as sirens and alarms in the sample that they studied; however, the perception of environmental warning sounds was reduced. Abel, Alberti & Riko (1982), showed that hearing protection did not have any effect for individuals with normal hearing but when individuals suffered from hearing loss, hearing protective devices reduced speech intelligibility considerably. Taking all these points into consideration, it would seem that hearing protective devices do serve a purpose. Nevertheless, they are not without faults, even allowing for proper induction, instruction and adaption. Furthermore, as Kielblock (1986) points out, hearing protection devices should be seen as an interim measure only until more effective noise reduction strategies can be implemented. In other words, noise intensity should be reduced at the source via quieter machinery rather than minimising noise for the receiver via hearing protective devices.

WHETHER RESPONDENTS WERE GIVEN A CHOICE OF HEARING PROTECTIVE DEVICES

Analysis of data revealed that 27 (50,9%) of respondents reported not being given a choice of hearing protective devices. The publication entitled: "Noise: A Safety Stewards Manual" (1991) states that management must give each worker a number of different types of hearing protection to try out. Kielblock (1986) states that one of the reasons many hearing conservation pro-

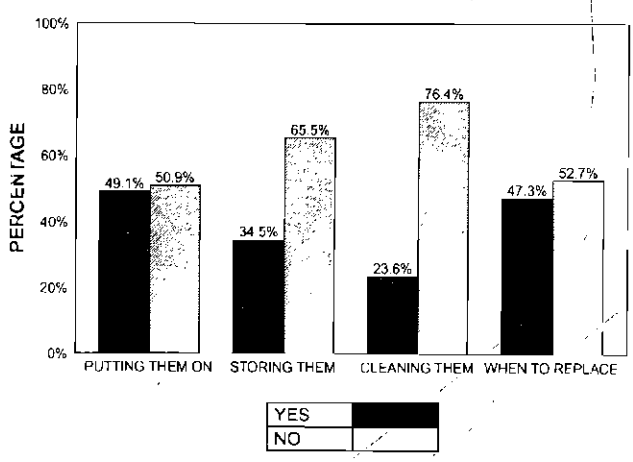

Figure 4. Training received on use of hearing protective devices. (N=55)

grammes fail is the lack of choice of hearing protective devices. It is therefore recommended that all workers be provided with a choice of hearing protective devices.

TRAINING RECEIVED IN THE USE OF HEARING PROTECTIVE DEVICES

Fig 4 shows that the majority of the respondents stated that they did not receive training in any of the four areas i.e., inserting and removing; storing; cleaning; and replacing hearing protective devices. Some of the workers in the study claimed that one of the reasons for not using their hearing protection was due to skin irritation or sores allegedly caused by these devices. Proper instruction in the above four areas, especially storing, cleaning and replacing may help in alleviating some of these complaints, thereby helping workers to protect their ears as well as preventing them from experiencing unnecessary irritation and pain. Moreover, the generally hot, dusty conditions which prevail in many underground mining areas and which tend to cause mine workers to perspire profusely, further underscores the need for proper cleaning and storage of hearing protective devices. Hence instruction in the use and care of hearing protectors could probably be more cost effective for the mine than treating ear infections and paying hearing compensation claims. This type of educational strategy could also improve the success rate of hearing conservation programmes.

VIEWS REGARDING A HEARING CONSERVATION PROGRAMME

The vast majority of the respondents i.e., 52 (94.5%) felt that a hearing conservation programme was necessary and requested that the mine should start one. These results imply that these mine workers were motivated and therefore, if a comprehensive, integrated hearing conservation programme was started and properly implemented, there appeared to be a good chance of success being achieved. The publication entitled, "Guidelines for the Implementation and Control of a Hearing Conservation Programme in the South African Mining Industry" (1988) states that the success of many hearing conservation programmes hinges on the extent of voluntary participation which in turn, stems from personal conviction. The mine workers in this study displayed an attitude conducive to the successful implementation of a hearing conservation programme.

Many respondents i.e., 39 (70.9%) realised that although the mine had implemented legislative guidelines in terms of hearing conservation, the mine had nevertheless, not implemented a comprehensive hearing conservation programme as defined in the questionnaire i.e., a programme which teaches mine workers, union officials and management how to reduce noise levels, how to conserve or save workers' hearing and how to prevent hearing loss. For this reason many of the respondents i.e., 39 (70.9%) correctly stated that the mine did not have a hearing conservation programme. Although the mine had installed noise warning signs, issued free hearing protective devices, provided hearing tests every year and covered the topic of hearing in some ten minute lectures, these factors do not constitute a comprehensive, integrated hearing conservation programme. Views articulated by the majority of respondents also highlighted the mismatch between what providers and recipients of a hearing conservation programme perceive as an adequate programme. The respondents who stated that the mine did have a hearing protection programme incorrectly assumed that the safety measures which had been legislated for, and which were being carried out, constituted a comprehensive HCP.

ADDITIONAL COMMENTS

The respondents were given the opportunity to express any further comments. This item was formulated as an open-ended question. The following are examples of some of the responses furnished:

- "Less noise on the mine."
- "Give feedback on results."
- "Would like more information on hearing protective devices."
- "If my hearing is becoming worse, who do I complain to? Will I lose my job?"
- "Would like to see a hearing conservation programme implemented on the mine."
- "Would like to know if the mine has a hearing conservation programme."
- "Would like a hearing test to be done every 6 months and the doctor must look inside the ear to see that there is no irritation, dirt or sore."
- "There is a lot of noise in the working place like the machines and fans. The mine must try to reduce the noise."
- "Would like more training about ears, noise and hearing."

These verbatim responses indicated that the mine workers in the study appeared to be lacking knowledge and were motivated to obtain help, guidance and assistance. The reason for this was probably due to their experience of working in noisy conditions and experiencing the effects of noise.

CONCLUSIONS

The main finding that emerged from the study was that, in terms of knowledge, respondents were poorly informed regarding the fact that noise was a health hazard. Furthermore, respondents' knowledge appeared to have been derived from the personal experience of working in noisy environments for many years rather than from educational input. Contrary to expectations expressed by Kielblock (personal communication, 1994), the majority of respondents did not view deafness as a status symbol and therefore did not have a positive attitude towards a hearing loss. They were motivated to protect themselves against deafness and to be educated about hearing and the effects of noise. Furthermore, the mine workers' demonstrated positive attitudes towards wearing hearing protective devices in situations which they themselves perceived as noisy. They also complained about lack of comfort when wearing the devices as well as feelings of insecurity due to the inhibition of communication and the inability to hear warning signals. These were the primary reasons furnished by workers for only wearing these devices in situations perceived as noisy by the miners themselves.

It is important to note that this study was conducted on a relatively small, unrepresentative, non-probability, convenience sample, which precludes generalisation

across the mining industry as a whole. Nevertheless, the findings from the study do have implications for clinical practice of audiologists; hearing conservation in the mining industry; further research; and the training and education of speech-language pathologists and audiologists.

Clinical Practice of Audiologists

The study highlighted the need for audiologists to play a vital role in the area of education and worker empowerment to help ensure successful hearing conservation programmes. According to the National Health Plan (1994), health policy in South Africa advocates a primary health care (PHC) approach which incorporates health programmes and services that emphasize both prevention and rehabilitation, and identify high-risk and under-served occupational groups. The audiologist would appear to be ideally equipped with knowledge and understanding in the area of hearing and noise induced hearing loss, to ensure that health policy and related legislation benefit at risk groups such as the mining population.

Hearing Conservation in the Mining Industry

Findings from the study clearly show that there is more to a successful hearing conservation programme than simply implementing the safety regulations for hearing supplied by the SABS. The implication is that although mines such as the one where the study was conducted, appear to be making a concerted effort to conserve hearing, there is a need to establish comprehensive hearing conservation programmes which incorporate all the factors mentioned in both the Guidelines for the Implementation and Control of a Hearing Conservation Programme in the South African Mining Industry (1988), as well as the publication entitled "Noise: A Safety Steward's Manual" (1991). In particular, it is recommended that:

(1) Greater use be made of audiologists in the education of mine workers regarding noise as a hearing hazard.
(2) Results of hearing tests be explained to miners.
(3) Workers be provided with a choice of hearing protective devices.
(4) Mine workers be given training in the insertion, removal, cleaning, storage and replacement of hearing protective devices.

Research

Results from the present study cannot be generalised due to the relatively small convenience sample used. It is therefore recommended that the study be replicated on a larger, more representative sample which would more realistically reflect the mining populations' knowledge and attitude towards hearing loss and the use of hearing protective devices. Other recommendations for future research include the following:

- Similar questions as the ones posed in the present study questionnaire could be put to a group of novice mine workers to see if similar results are obtained.
- Knowledge and attitudes towards noise induced hearing loss and the use of hearing protective devices could also be related to audiometric assessments of respondents.
- Similar studies on the knowledge and attitudes of workers towards noise induced hearing loss and the use of hearing protection devices, could be carried out with other at risk occupational groups in commerce and industry e.g., airline pilots and construction workers.

Training and Education of Speech-Language Pathologists and Audiologists

At present the training curricula of speech-language pathologists and audiologists seem to focus largely on the theory underpinning noise induced hearing loss and the principles of hearing conservation. It is recommended that more opportunities be provided for students to acquire the practical experience of educating various occupational groups regarding the hazards of noise, and of actively implementing hearing conservation programmes in the community, particularly in high noise-risk industries.

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APPENDIX

ACTS AND RELATED GUIDELINES

SABS Code of Practice for the Assessment of Noise Exposure During Work for Hearing *Conservation Purposes.* SABS 083-1970, South African Bureau of Standards: Pretoria.

SABS Code of Practice for the Measurement and Assessment of Occupational Noise for *Hearing Conservation Purposes.* SABS 083-1983 as amended 1986 and 1989, The Council of the South African Bureau of Standards: Pretoria.

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