Prevalence of noise induced hearing loss among employees at a mining industry in Zimbabwe

*Chadambuka A, Mususa F, Muteti S

Department of Community Medicine, University of Zimbabwe

Abstract

Background: Noise induced hearing loss (NIHL) is within the top five occupational illnesses in Zimbabwe. Workers at a mining company complained about loss of hearing at the mine clinic.

Objective: To determine the prevalence of NIHL among employees at the Mine.

Methods: We conducted a descriptive cross sectional study at the mine. Workers were proportionally selected to represent all the mine departments or working areas. We measured noise levels at various mine sites, conducted a walk-through survey to observe noise related worker practices and conducted audiometric testing.

Results: Mean age for workers was 34.8±7.6 years and the mean duration of exposure to noise was 7.5±1.2 years. All workers could define noise. Ninety (53%) workers attributed NIHL to noisy work environment. Excessive noise levels were in Plant Processing (94 dBA), Underground Mining (102 dBA) and (Underground Workshop (103 dBA). Sixty two (36.7%) workers had NIHL. NIHL increased as a function of age (chi square=30.99 df=3 p<0.01) and was associated with work area (chi square=24.96 df=5 p<0.01). Observed workers took heed of noise warnings. There was no documented hearing conservation program at the mine.

Conclusion: The prevalence of NIHL of 37% is high. Age and work area were associated with NIHL. Studies reported that age tends to distort the relationship between noise exposure and NIHL. Mine management should institute a hearing conservation program to protect employees against hazardous noise. Management may meanwhile use administrative controls and adhere to permissible exposure limits according to the noise regulations.

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Introduction

Hearing impairment is the most frequent sensory deficit in human population. Globally, over 275 million people are affected and 80% of them are in low- and middle income countries[1]. Hearing loss gives rise to problems in recognizing speech, especially in difficult environments, reduced ability to detect, identify and localize sounds quickly and reliably. These sounds may be warning or alarm signals, as well as music and birds singing. Having this communicative disability affects the hearing-impaired people and people in their environment e.g. family members and fellow workers. Studies have shown that uncorrected hearing loss gives rise to poorer quality of life, related to isolation, reduced social activity, and a feeling of being excluded, leading to an increased prevalence of symptoms of depression[2].

***Corresponding author:**
Addmore Chadambuka
Department of Community Medicine
University of Zimbabwe
Zimbabwe
Email: achadambuka1@yahoo.co.uk

The World Health Organisation Programme for the Prevention of Deafness and Hearing Impairment is concerned with developing and promoting strategies for prevention of the major causes of hearing impairment and deafness which constitute public health problems. The World Health Organisation (WHO) carried out an assessment of the global disease burden from occupational noise. Noisy workplaces have a heavy impact on health around the world. Millions of years of healthy life are lost due to occupational noise-induced hearing loss. Worldwide, 22 per cent of disabling hearing loss in men is caused by occupational noise. Men are generally more exposed than women to excessive noise in the workplace[3-4].

In developing countries occupational noise accounted for about 3.8 million years of healthy life on an annual basis in 2000 compared to 0.3 million years in developed countries[5-6] Noise induced hearing loss represents a much heavier burden in developing countries than in developed regions of the world. The difference is mainly due to lack of noise prevention programs and awareness of the consequences of the excessive noise exposure[6]. Social

noise exposure has been increasing over the last 10 to 15 years, including in more developed countries. This occurred particularly through attendance at discos and to a lesser extent through the use of personal stereos[7] but has been found without significant effect on hearing threshold levels[8]

Summary statistics on noise exposure are not available for most industrializing and non-industrialized countries; however, high occupational noise exposure levels were reported in 17 studies conducted in 12 countries in South America, Africa and Asia. These high noise levels occurred in a wide range of workplaces, including manufacture of foods, fabrics, printed materials, metal products, drugs, watches and in mining. Many of these studies reported hearing losses in exposed workers[6].

In Zimbabwe, the Factories and Works Act Chapter 14:08 requires employers to take all practical steps for the health of employees and persons lawfully on the premises. All employees should be properly trained and when under supervision, are properly supervised by a competent person, provided with personal protective equipment and clothing where necessary and that these are used, safeguarded against dangerous machinery, hazardous processes , noise, dust and provided with a safe and healthy work environment[9].

Noise induced hearing loss (NIHL) is within the top five occupational illnesses in Zimbabwe and among the top three compensable occupational illnesses after backache and pneumoconiosis[10]. Zimbabwe has a law which specifically protects workers exposed to several hazards in industry including mining establishments[11].

Mine X is a major underground mining concern in Zimbabwe. NIHL is one major problem facing mining workers today. The occupational environment at the mine is filled with heavy machinery and equipment for drilling and crushing, and processes that produce potentially hazardous noise. Twenty nine workers (5.5%) at the mine (n=524) complained about loss of hearing at the mine clinic over a period of two years. The latest survey conducted by the Ventilation Officer at the mine showed that noise level was between 64 dB (A) in administration areas and 108.5 dB (A) in underground mining sections. At the Mine, the standard noise acceptable is 85 dB (A) and the Factories and Works (General) Regulations Section 6 prescribes an exposure limit to noise of 90 dB (A) for an 8 hour shift. There are two shifts that operate at the whole mine that work each an extra four hours on overtime which is against the permissible exposure limit (PEL).

Old audiometry records show the mine at once compensated three employees on medical grounds after suffering NIHL costing the company US$2 million in claims.

The National Social Security Authority (NSSA) suspended certain operations in 110 firms for failing to comply with occupational safety and health laws in 2010[12]. There was need to investigate and understand the occupational noise levels, while also assessing the effectiveness of occupational health and safety programs in place.

This study of NIHL at the Mine was important to determine the prevalence of this occupational illness and gather baseline information for further studies and ensure legal compliance and improvement of internal operations to reduce danger (hearing impairment), downtime, and as part of Occupational, Health and Safety Management System (OHSAS)18001. We determined the prevalence of noise induced hearing loss among employees at the Mine.

Methods

We conducted a descriptive cross sectional study. This included a walk through survey and an audiometry testing. The study was conducted at a mining town in Zimbabwe. The study population consisted of all 524 mine employees. Workers were proportionally selected to represent all the mine departments or working areas. We listed workers from each department and randomly selected workers proportional to department size from these lists to participate in the study. We used a sample size of 169 workers assuming a prevalence of noise induced hearing loss to be 3% and a worst acceptable result of 5% at 95% confidence interval.

Audiometry testing was done by trained research assistants from 18 February 2012 to 08 March 2012 and the degree and type of NIHL was classified according to Goodman[13] and Cahart[14]. The procedure adopted included a detailed case history and audiometry. The audiometric tests were conducted in a test booth with an ambient noise of 30 dB (A) located at the mine clinic. The tests were conducted at frequencies from 125Hz through to 8000Hz in octaves using a calibrated Kamplex Audiometer (Model 27) and recorded on a standard audiogram form (figures 1 and 2).

Figure 1: Participant entering into audio booth for audiometric testing

Figure 2: Technician selecting frequencies and manipulating hearing level during audiometric testing

A structured questionnaire was used to collect data from study participants on demographic variables and knowledge of hearing protection and its use by trained research assistants. We reviewed medical records for 169 workers to check for symptoms related to NIHL. An observation checklist was to capture practices of workers in relation to noise prevention and control while at work. The practices observed included observing noise warning signs when approaching noisy areas; use of earplugs and earmuffs or other noise controls when using noisy machinery or working in a noisy areas and storage of ear plugs and earmuffs. A participant observer was used to capture practices so that workers would not know they were being observed. We measured noise levels at different work sites. Readings were done by three trained independent readers and the average noise level was calculated. Two key informants from the office of health and safety were interviewed on noise control.

We analysed quantitative data using EPI Info 3.5.1 to generate frequencies. Qualitative data was analysed manually. We obtained permission to conduct the study from Mine Management and the ethical clearance from the University of Zimbabwe Ethics Committee. We obtained informed written consent from our study participants to conduct audiometric testing and respond to questions and confidentiality was assured. We informed Management of workers affected by noise induced hearing loss for corrective action. Health education was given on the importance of using hearing protection where it's required and the consequences of not using it.

Results

We conducted face-to-face interviews with 169 workers. Of the 169 persons interviewed only 11 were women and 158 were men (table 1). The mean age for the workers was 34.8 years (standard deviation (ó = 7.6) and the mean duration of exposure to noise was 7.5 years (ó = 1.2). Forty seven (27.8%) workers had attained the Zimbabwe Junior Certificate of Education. Ninety seven (57.3%) of the workers interviewed had attained Ordinary Level education coupled with a significant number of in-service certificates of competence and attendance. Thirteen (7.7%) workers had attained Advanced Level, the rest (12) 7.2% had attained diplomas and competence certificates from the Ministry of Mines.

Table 1: Distribution of mining employees and the number interviewed

Work area	Number of workers	Number interviewed
Administration	43	7
Plant Processing	48	13
Plant Engineering	35	9
Technical Services	64	23
Underground Mining	215	83
Underground Workshop	25	14
Contractors	94	20
Total	524	169

Knowledge on noise induced hearing loss

A sample of 169 mine workers (84 from underground and 85 from surface operations) were interviewed. All the workers could define noise with 96 (56.9%) reporting that it was sound that interfered with hearing normal conversation and 63 (37.2%) reporting it as unwanted sound. One hundred and seven (63.3%) per cent of the workers reported having heard of NIHL before. Ninety (53.2%) workers attributed NIHL to working in noisy environments, 69 (40.8%) to improper or non-use of hearing protection and 10 (5.9%) to intermittent but very loud sounds. About 140 (82.8%) employees reported using hearing protection devices because they are always exposed to noise and 13 (7.5%) reported using hearing protection whenever they entered a noise designated area. One hundred and sixteen (68.6%) workers reported using earplugs while 53 (31.4%) used earmuffs. About 160 (94.7%) workers reported they were trained in using hearing protection devices.

Observation of work practices

The observations recorded in the 7 days' work practice observation checklist indicate that the optimum operating conditions for the prevention of NIHL were achieved. Most workers (90±5%) observed noise warning signs and wore their hearing protection in all noise designated areas. None was observed using noisy machinery without hearing protection.

Noise survey at the mine

Some mine areas had excessive noise levels (Plant Processing 94 dB), (Underground Mining 102 dB) and (Underground Workshop103 dB) since the acceptable level is 90dB for an 8-hour period. These areas had no engineering control measures in place to reduce noise levels. The noise levels measured at different sites at the mine are shown in table 2.

Audiometry Results

A total of 169 workers from 19 to 63 years of age were seen on site at Mine Clinic, had both ears tested for noise induced hearing loss. Sixty two (36.7%) workers had noise induced hearing loss. This was classified as mild in 41 (66.1%), moderate in 17 (27.4%) and severe in 4 (6.5%) of the affected workers. No pre-exposure audiograms were available for the workers were available for comparison as baseline hearing level. NIHL tended to increase as a function of age. The age distribution for workers observed to have noise induced hearing loss at 4 kHz is shown in table 3. There is a direct relationship between NIHL and the duration of exposure. The longer the duration of exposure to noise is, higher the prevalence of NIHL. The relationship between the duration of exposure to noise and the development of hearing loss at 4 kHz is shown in table 4.

Table 2: Average noise levels dB(A) Measured Underground and on Surface at the Mine, 2011

Location	Noise reading 1	Noise reading 2	Noise reading 3	Average noise dB(A)
Mining underground				
725 ramp booster fan	109.0	108.3	107.0	108.1
800x5pump station	100.0	99.0	102.0	100.3
815-580 DD2 Exhaust fan	104.0	102.0	108.8	104.9
815-635 x/c forces fan	96.0	97.0	95.6	96.2
815-670 x/c (Rig 22)	109	105	110	108
LHD 10 @ 800-950 slot	105	109	110.2	108.1
920 diamond drilling machine	96	99	99	98.0
South ramp 900 pump station	100	98	100.8	99.6
860 south ramp pump station	95.8	96	97	96.3
UG workshop	108.4	104.0	102	104.7
UG boiler shop	102	99	105	102.0
Workshop compressor	103	100	106	103.0
Technical services				
Grader	90	94	92.4	92.1
TD 20	104	102	108	104.6
Electrical workshop	69	75	71	71.6
Underground offices	69	66	63	66
Stores	74	69	68	70.3
Lab sampling preparation room	109	105	101	105
Administration				
Main offices	56	55	54	55
Civils workshop	100	102	101	101
Clinic	55	55	56	55.3
Plant processing				
Plant floor	106	100	109	105
Plant sag mills	99	109	105	104.3
Plant chutes	89	93	86	89.3
CV 3A	96	95	93	94.6
Plant boiler shop	94	96	95	95
Dewatering pumps	97	98	99	98
Plant processing pumps	95	95	92	94
Tank 0	91	87	89	89
Tank 1	90	91	87	89.3
Tank 5	85	86	88	86.3
Tank 6	95	96	94	95
High security gate	85	83	88	85.3
Carbon screen	88	91	87	88.6
CIL spillage pumps	95	96	94	95
Plant compressor room	96	94	95	95
High security gate	85	83	88	85.3
Plant mechanical, electrical shop	69	73	70	70.6
Crusher pad	87	86	85	86
New tailings budge pumps	102	106	105	104.3
Crusher control room	87	86	85	86

Data from interviews showed that 140 (82.8%) employees reported using hearing protective devices but despite reported use of protective devices, audiometry testing found 62 (36.7%) had NIHL. Most workers 36 (58.1%) affected by NIHL worked underground. Both key informants indicated that there was no documented noise hearing conservation program.

Table 3: Age Distribution among Workers with NIHL

Worker's Age	No. Tested	No. with NIHL (%)	No. without NIHL (%)
19-29	27	4 (15)	23 (85)
29.1-39	93	25 (27)	68 (73)
39.1-49	37	23 (62)	14 (38)
49.1+	12	10 (83)	2 (17)
Total	169	62 (37)	107 (63)

Chi square=30.99, df = 3, $p<0.01$

Table 4: Relationship between duration of exposure and NIHL

Duration of exposure (Years)	No. Tested	No. with NIHL (%)	No. without NIHL (%)
1-5	85	23 (27)	62 (73)
6-10	42	18 (43)	24 (57)
11-15	33	16 (48)	17 (52)
16-20	9	5 (55)	4 (45)
Total	169	62 (37)	107 (63)

Chi square=7.44, df = 3, $p<0.05$

Discussion

The prevalence of NIHL (36.7%) is higher as compared to the prevalence reported in other studies. The high prevalence at this Mine case could have been attributed to the non-existence of a documented hearing conservation program to protect the workers other than the use of PPE and lack of engineering controls. Because of the absence of baseline hearing levels, no conclusion can be made on the hearing threshold elevations recorded in the 62 workers. Some of them could have joined the company already with existing NIHL from their previous jobs. Amedofu *et al* in their study of hearing impairment among workers in gold mining in Ghana reported a prevalence of 23% in a population of 252 workers[15]. Masaka *et al* who determined the prevalence of NIHL at a Nickel mine in Zimbabwe showed that the prevalence of NHIL was 27.4% in a population of 168 employees which is much lower than what we found in this study[16].

The generally accepted standard regulation in most countries is that a noise level of more than 85dBA for an 8-hour daily exposure is potentially damaging. In Zimbabwe, The Factories and Works (General) Regulations, 1976 Part 2 of the Health and Safety section prescribes that, "No person shall be exposed to sound levels exceeding the limits, 90dBA, unless such person has been supplied with ear protectors"[17]. Noise levels in several working areas were higher than recommended. This may be a reflection that noise producing processes or equipment do not have adequate noise control measures.

Whilst 100% of the workers could define noise and knew that it caused hearing loss among the workers, the reported use of protective devices was not equally high, (82.8%), the actual practices as observed showed that 100% compliance to hearing protective devices usage was rarely achieved. This can be attributed to the worker attitudes and sometimes forgetfulness.

Age and duration of exposure in this study were related to NIHL. Other studies have reported that age tends to distort the relationship between exposure to noise and noise induced hearing loss[18, 19]. With increase in age, there are changes in hearing due to age (presbycusis) and this will add on to any existing NIHL giving the impression that older individuals suffer a greater degree of deafness than the younger workers. NIHL is a result of the total noise exposure over that person's lifetime and not just length of a single exposure to noise. The longer the exposure at excessive noise level the greater the degree of NIHL.

NIHL has been reported to be a function of work area with workers in noisy areas being affected most[20]. In this study, some workers were found with NIHL in areas normally thought to be

free from noise. This may be because those affected by NIHL are usually rotated to the noise free areas to prevent further exposure.

Conclusion

Occupational NIHL is a problem for the mine workers. Workers in plant processing, plant engineering and underground workshop were exposed to hazardous noise. The mine management should institute a hearing conservation programme to protect employees against hazardous noise. The hearing conservation must begin by providing each individual with information. The mine management should install engineering controls in areas exceeding permissible noise levels. Alternatively management may meanwhile use administrative controls and adhere to permissible exposure limits according to the noise regulations.

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Author contributions

Freddy Mususa: He was responsible for the conception of the problem, design, collection, analysis and interpretation of data and drafting the final article.

Addmore Chadambuka: Participated in the design, analysis and interpretation of data and drafting the final article and critical review of the final draft.

Shamiso Muteti: She was responsible for the conception of the problem, design, analysis and interpretation of data and drafting the final article.

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