Hearing-Impairment Among Workers in a Surface Gold Mining Company in Ghana

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SUMMARY

A study to determine the impact of hazardous noise on workers was conducted in a surface gold mining company in Ghana. The procedure adopted included noise survey, case history, otoscopy and conventional pure-tone audiometry. Five main areas were surveyed for hazardous noise namely, Pit, Processing, Ana Laboratory, Bore-hole and Mess area. The results showed that all the above areas except the Mess area produced noise levels above 85 dBA. Again, a total of 252 workers were seen at the company, and out of this number 59(23%) had the classical noise-induced hearing loss (NIHL) at 4KHz. In addition, NIHL increased as a function of age and duration of exposure. It is also noted that out of 81 workers with a pre-employment history of noise exposure, 41(51%) had NIHL. NIHL also varied with regard to job location. 14(6%) of the workers had hearing loss greater than 25 dB at the speech frequencies. Thus, factors not under the control of the company may affect the hearing of an employee.

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Introduction

Occupational noise exposure is the most common cause of noise-induced hearing loss (NIHL) in both developed and industrialized world. Although excessive noise exposure has been recognised as harmful to ears, very little attention has been paid to reduce noise at the source or to prevent it's transmission from the source to the worker. It is important for the employer in an industrial setting to obtain baseline audiograms so as to determine the amount of hearing loss for which he will be responsible. The generally acceptable standard regulation in most countries including Ghana is that a noise level of 85 dBA for an 8 hour exposure is potentially damaging [1]. In several developed countries, awareness and the acceptance of the reality of noise-induced hearing loss as an occupational hazard has increased. As a result of this, there a gradual change in focus from recognising and treating hearing loss to preventing it through effective proactive hearing conservation programs [2]. In developed countries, employers in factories and mining companies are required by law to develop hearing conservation programs to protect workers against hazardous noise. In Ghana, there is a law which protects workers from hazardous noise exposure [3] but there is no law which specifically protects workers exposed to hazardous noise in mining companies even though the potential danger to NIHL in this industrial setting has been recognized [4]. In Ghana there has not been any study on occupational hearing loss among workers in surface mining companies, even though a study has been conducted on workers in a large underground mining company. There is therefore the need to conduct an investigation in surface mining companies in Ghana so as to determine the potential risk to workers in this work setting.

Materials and Methods

Instrumentation and noise survey

The decision on instrumentation depends on the goal of measurement. In our particular situation, we want to know if the noise

in the areas to be surveyed is such that it can lead to permanent hearing damage and if noise control measures are needed for the source of noise under investigation, or if workers in the noisy environment need to be protected. The Quest Sound Level Meter, Type 2 Model 2700 was used to measure average sound values because it is versatile and simple to use. Calibration of Sound Level Meter (SLM) was done in December 1998 by an engineer from Intra-Acoustics company in Denmark since facilities for calibration are not locally available. The desired response of the SLM was set at Slow position in the processing, pit, bore-hole, Mess and Ana-laboratory areas in the mines. During the measurement, the microphone was located in such a way that it will not be in the acoustic shadow of any obstacle or in appreciable field of reflected waves.

Audiometry

A total of two hundred and fifty-two workers, aged <20 to >50 years in a large surface gold-mining company were seen on site. The procedure adopted included a detailed case history, otoscopic examination and audiometry. The audiometric tests were conducted in a quiet room located near the hospital at the mines. The tests were conducted at the frequencies from 500 Hz through 800 Hz in octaves using a Kamplex Audiometer (Model 27). Audiograms were considered normal if no threshold between 500 Hz through 8000 Hz exceeded 25 dB[5]. Audiograms depicting the classical sign of NIHL with the characteristic notch at 4 kHz were also analyzed. The degree and type of hearing loss were also determined according to Goodman and Cahart[7] respectively.

Results

Table 1 displays average noise levels in dBA in some selected sites in the mines. As can be seen, noise level in the pit, processing, bore-hole and ana-laboratory areas exceed 85 dBA. The highest level of noise recorded are, Processing area machines: Ball Mill 100 dBA, Sag Mill\99 dBA and Crusher Top 104 dBA etc; Pit area: Tam Rock 120 dBA, Geo Drill 105 dBA, Escavator-11 105 dBA and Cat Dz 11, 95 dBA etc. and Analab. area machines: Keegor Mill, 100 dBA, Jew Crusher, 100 dBA and Lead Extractor, 88 dBA etc. We do observe that even though machines at the Pit area produce higher noise levels than the other areas, the nature of the work in the areas is such that fewer workers are exposed to such high levels of noise.

We see in Table II age distribution of NIHL among the workers. As can be observed, hearing loss at 4kHz tended to increase as a function of age. For instance at the age range of 20 - 29 years, 6% of workers had hearing loss greater than 25 dB at 4 kHz. On the other hand, at the age 50 years and above, 78% of workers had NIHL. In addition, Table III contains the relationship between the duration of exposure to noise and the development of hearing loss at 4 kHz. It can be observed that there is a direct relationship between NIHL and duration of exposure. The relationship were, 1 - 5 year exposure, 29(18%) workers out of 161 had the characteristic notch at 4 kHZ; 6 - 10 years, 17(31%) out of 54 workers; 11 - 15 years, 9(33%) out of 27 workers had 16 - 20 years exposure, 4(40%) out of 10 workers.

Table IV depicts number of workers with a history of pre-employment exposure to hazardous noise and the development of NIHL. Observe that out of 47 workers with a history of noise exposure of <5 years 20 (43%) had NIHL. Again, out of 24 workers with a pre-employment exposure of 5-10 years, 13(54%) had NIHL; and finally, 8(80%) out of 10 workers with a pre-employment exposure of more than 10 years had NIHL. As to be expected, as the duration of pre-employment exposure is increased, the number of workers with hearing-impairment has also increased. We also see in Table V the distribution of hearing loss at 4 kHz among workers at various work settings. For instance, out of a total of 252 workers studied, 57 of them work at the processing area, and out

of this number 23 (40%) had NIHL. Again 53 individuals work at the Pit area, and out of this number 9 (27%) had the characteristic notch at 4 kHz and so on. Table VI displays speech range classification of hearing loss among workers. We do note that 14(6%) of the workers tested had hearing loss greater than 25 dB at the speech frequencies (500 Hz, 1000 Hz and 2000 Hz). Eight of them had a mild hearing loss, which the remaining 6 workers had a moderate - profound hearing loss. The hearing loss was bilateral in 5 cases and unilateral in one case. There are 3 cases of conductive hearing loss, 2 cases of mixed hearing loss and 9 cases of sensorineural hearing loss.

Table 1. Noise Levels At Survey Sites In The Mines

SITE	AVERAGE NOISE LEVEL (dBA)
Pit (drilling machines)	98
Processing Area	95
Ana Labs	88
Bore Hole Area	86
Mess Area	82

Table 2. Age Distribution Of Occupational Nihl Among Workers

AGE	NO. TESTED	NO. WITH NIHL	PERCENT
20-29	70	4	6
20-39	116	25	22
40-49	57	23	40
50+	9	7	78
All Ages	252	59	23

Table 3. Relationship Between Duration Of Noise Exposure And Nihl (>25 Db Hl)

EXPOSURE TIME (YEARS)	NO. TESTED	NO. WITH NIHL	PERCENT
1-5	161	29	18
6-10	54	17	31
11-15	27	9	33
16-20	10	4	40
All Ages	252	59	23

Table 4. Pre-employment exposure and noise-induced hearing loss

YEAR	NO. SEEN	NIHL	PERCENT
<5	47	20	43
5-10	24	13	54
>10	10	4	40
Totals	81	41	51

Table 5. Noise-induced hearing loss at various work settings

WORK SETTING	NO. SEEN	NO. WITH NIHL	U/BILATERAL	%
Processing	57	23	5,18	40
Pit/Survey/Field	26	7	3,4	27
Mining	13	1	1	8
Security	35	13	8,5	37
Workshop	19	7	3,4	37
Administration	62	14	9,5	23
Geology	14	1	1	1
Utility	17	3	1,2	18
Loss Control	8	-	- -	-
Machine op.	17	3	7,10	18

Table 6: Speech range classification (PTA) for workers tested in the mines (in the worse ear only

DEGREE	NO. TESTED	U/BILATERAL	PERCENT
Normal	238	-	94
Mild	8	8,3	3
Mild-moderate	-	-	-
Moderate	2	1,1	1
Moderate-severe	2	1,1	1
Profound	2	2	1
TOTALS	252	9.5(14)	100

Discussion

This study was done to determine the noise levels in a surface gold mining company and also to find out if the noise levels have any effect on the hearing capabilities of workers in the company. Our data has shown that the Pit and the Processing areas produced the highest levels of noise in the mines. On the average, noise levels at the Pit area was 98 dBA while that of the Processing area was 95 dBA. The rest were Ana Laboratory, 86 dBA and Mess area 82 dBA.

The generally accepted standard regulation in most countries is that a noise level of more than 85 dBA for an 8 hour daily exposure is potentially damaging [1]. In Ghana, there is no law governing workers exposed to hazardous noise levels in mining companies. However, the mines inspectorate uses a noise level of greater than 85 dBA for an 8 hour daily exposure as the standard to advise mining companies on the importance of hearing conservation [4]. Thus, according to the standard adopted in Ghana, the noise levels in the processing, Pit, Ana Labs and Bore-hole areas unlike the Mess are hazardous.

The standard used by the mines inspectorate in Ghana (>85 dBA) was deduced from the ISO standard of Europe and ANSI standard of USA. This standard is based on the equal energy hypothesis (EEH) which assumes that for any noise exposure, the degree of hearing loss is proportional to the total amount of energy exposure (Energy = power dB x duration). The EEH is attractive because it is a single number of estimate the noise hazard and it is a simple quantity to measure and apply [8].

We do note that 59 (23%) workers seen had the characteristic notch at 4 kHz. By convention, the 4000 kHz audiometric dip has been traditionally regarded as the classical finding in NIHL but identical audiometeric threshold has also been described in other populations and due to large varieties of endogenous and exogenous agents. For example, while NIHL has been adduced as the cause of 4 kHz dips found at routine audiometric testing of school children [9], others have considered genetic influence to be more likely etiological factor, at least if there is no history of significant noise exposure [10]. Since no pre-exposure audiograms are available on the workers seen in this study, no conclusion can unfortunately be made as to the possible contribution of endogenous and exogenous factors to the threshold elevations recorded in the 59 workers at 4 kHz. The 23% NIHL reported in this study is slightly higher than 20% figure reported by Amedofu et.al [11] in the underground mine survey. We also found that hearing loss increased as a function of age. For instance, between the ages of 30-39, 116 workers were tested and out of this number, 25(22%) had NIHL. On the other hand, 9 workers above the age 50 years were seen and out of this, 7(78%) had NIHL. Gallow and Glorig [12] noted that the permanent threshold shift (PTS) found in noise exposed people results from combined effects of chronic noise exposure and aging. The same finding was reported by Amedofu et al.[11]. Studies by Mass [13] indicated that the growth of the NIPTS at 4 kHz is most rapid during the first 10 to 15 years of exposure after which the loss seems to slow down and plateau. In another vein, other studies [14, 15, 16, 17] have shown that the effects of chronic noise exposure are more evident in young subjects (about 30 years) where they cannot separate the hearing loss due to aging. Beyond the age 50 years, the PTS does not grow appreciably, but age related hearing loss continues. Thus, the increase in hearing loss later in life is related to aging and not to noise per se.

Another question we raised was whether workers who were exposed to hazardous noise prior to their entry into their present employment had NIHL. Here again, we found that there is a direct relationship between duration of exposure in previous employment and the development of NIHL (Table IV). Seen thus, it is imperative for gold-mining companies to obtain base-line audiograms on each new employees to determine hearing status so as to avoid payment for NIHL for which the company is not responsible.

We also found that hearing loss at 4 kHz was a function of occupation with workers in the Pit area being the most at risk. To be true, the Pit area had the highest noise level (98 dBA followed by the processing area (95 dBA). The differential effect of type of occupation on the level of NIHL was also reported by Amedofu et al [11] in Ghana and Wahab and Zaidi [19] in Pakistan. In this study11, it was reported that miners who work underground were the most at risk for NIHL. This suggests that the spread of the effect of NIHL among workers in mining companies would depend on the type of company, (surface or underground).

Out of the 252 workers seen, 94% had normal hearing, while 14 (6%) had a hearing loss in the speech frequencies ranging from mild to profound. Five had bilateral hearing loss while nine had unilateral hearing loss. In two of the five cases with bilateral hearing loss, an assymetrical sensorineural hearing loss was found.

Although a high right-left correlation has been reported in guinea pigs [20], assymetry is not uncommon in industrial NIHL [21], especially in those with lateralized noise sources [1]. In addition, unilateral threshold elevation at an early stage of an employees noise exposure prior to development of bilateral noise-induced hearing loss [22] has been observed. So far we have pointed out that exposure to hazardous noise can cause NIHL. There is another argument that the effect of noise and aging along might not account for the NIHL that we see in the work place. Fundamental to this notion is the report that the effect of noise in the work place can be exacerbated by temperatures, vibration and chemicals

[23, 24]. Therefore, a greater understanding of the effects of combined exposures on hearing is needed so that more effective strategies can be developed for the prevention of hearing loss.

Conclusion

Occupational NIHL is known to be a problem for industrial workers, miners, police, fire-fighters and the military. Our study at the surface mine in Ghana has shown that there are some areas in the mines, namely, Processing, Pit, Ana Labs and Bore-hole areas where workers are exposed to hazardous noise (>85 dBA). We noted that 59(23%) of workers in the mining company had the characteristic notch at 4000 Hz. This is slightly higher than the 20% figure reported for underground mining company in Ghana. This point should, however not be stretched too far, since populations from the studies have not been randomly sampled. In Ghana, there are general guidelines for mining companies on safety standards, but to date, there are no laws, which protect workers exposed to hazardous noise. Again, our study has shown that there is a direct relationship between NIHL and age and duration of exposure.

There are observations that the basic similarities and differences between PTS and age related hearing loss are not well understood. Out of the 252 workers seen, 14(6%) had various types and degrees of hearing loss. Thus, it is very important for mining companies to develop hearing conservation programs to protect their workers against hazardous noise. Indeed, hearing conservation must begin by providing each individual with information. NIHL is insidious, permanent, irreversible, causing communication interference that can substantially affect the quality of life. As such, it is in the interest companies to evaluate each employee in terms of his or her medical history and non-workplace noise. Significantly, the history should stress pre-employment exposure since it was revealed that 51% of workers with pre-employment exposure to hazardous noise had NIHL. The hearing loss varied with duration of exposure. To be true, factors not under the control of the company may affect the hearing of an employee. As such, employees who engage in noisy hobbies or who may hold noisy second jobs should be encouraged to use effective hearing protection devices during their noise exposure. Company sponsored education programs should stress the importance of good hearing conservation practices on and off the job and also inform employees about other diseases that may affect their hearing.

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