Assessment of Noise and Its Impact on Miner's Health

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Abstract. Noise is considered as the one of the main occupational health and safety concern. When it comes to industry like mining where heavy earth moving machineries were used for basic operations, noise is generated hugely. Numerous previous studies have raised this concern but those studies are limited to evaluation only. This study is done not only to evaluate the noise but also to find out whether the noise induced hearing loss (NIHL) is caused or not. The findings of this research confirms that the noise is above the DGMS standards and mine workers are subjected to risk of NIHL assessed through qualitative questionnaire survey. Immediate preventive measures should be taken by the mine management to reduce the NIHL.

Keywords: Occupational health and safety · Noise-pollution · Noise induced hearing loss · Miner's health

1 Introduction

Noise pollution is considered as the one of the great concerns in the mining industry. With rapid growth of industrialisation, hazards are also increasing and noise is also increasing with it. Noise exposure has increased with technology and machines for better production over the course of time. Noise affects the whole human population, particularly those who work in industries with a large number of machines and those who spend their days in open-air or underground mining factories [1]. Long-term noise exposure may create a variety of medical, physiological, and psychological issues. The unfavourable health impacts of exposure to extreme noise comprise of hearing damage, sleep difficulties, meddling with articulated communication, cardiopulmonary issues, psychological health disorders, poor productivity, bad societal behaviour, and irritation responses [2]. One of the most irritating characteristics of noise is that it disrupts conversation.

Not all sounds are considered as noise pollution. Noise exceeding 65 decibels is considered as noise pollution according to the World Health Organization (WHO). Noise is the undesired and unpleasant sound that causes discomfort in humans. The unit of measurement is decibels (dB). Hearing damage and excessive noise exposure continue to be an issue in the mining sector. The scientific researches concluded that due to dialog meddling between workers and people, the workers were usually exasperated.

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Less auditory input may result in reassignment of the brain's auditory centres to other activities, or degeneration and atrophy of the acoustic cortex [3, 4].

The studies had revealed high exposure to perilous noise to be common at the tested U.S. hard rock miners, where noise level produced by few of the hard rock mining equipment were found to be in superfluous of 113 A-weighted decibels (dBA) [5]. Investors and organizations must take mitigation action against this escalating risk. The findings revealed a considerable positive association between noise and its associated health effects [6]. As the noise level exceeds 70 decibels, tiredness levels begin to differ significantly from an environment without noise (50 dB) [7]. Levels of noise pollution were strongly linked with myocardial, ear, and sleep disorders [6]. In the polynomial regression analysis, the association between noise level and cardiovascular and sleep problems was shown to be larger than that between noise level and hypertension.

A study conducted on three selected safety behaviour gauges: attention, reaction, and fatigue, and analysed how coal mine machinery noise effects these safe working aptitudes. The findings demonstrated that noise may impact the concentration, response time, and weariness of miners. Significant changes in attention are noticed when the ambient noise level exceeds 80 decibels compared to a place without noise (50 decibels). Significant increases in tiredness are noticed when the sound intensity is 70 dB or above compared to an ambient without noise (50 dB). The research found that the sensitivity of optical stimuli is higher than that of auditory stimuli: the response time to auditory stimuli becomes statistically significant at 70 dB, but the response time to optical stimuli becomes statistically significant at 80 dB. Hence, visual stimuli may be used to improve safety systems in a noisy environment. It means that locations with lower noise levels are safer for workers [7]. A research survey in 2017 concluded that study articles over the last twenty years revealed research shortages. Likewise, it also showed the following future views of noise pollution studies: the emphasis should be placed on investigating the link between exposure and effect by conducting audiometric investigations. The noise- annoyance graph should be shown so that the impact of exposure may be better understood [8].

Studies have demonstrated that excessive noise in the workplace reduces employee productivity and causes irritability, headaches, hearing problems, and loss of attention during work hours [9]. It was estimated in 2007 that nearly half of the mining industry's workers in South Africa was subjected to hazardous occupational noise, and that over 90% of these individuals work in zones where the noise levels are in excess of the 85 dBA time-weighted average, over 11% employed in locations where noise levels are even more hazardous [10]. It was discovered that 7% of US workers who had never been exposed to workplace noise had hearing difficulties, 5% had tinnitus, and 2% had both symptoms. However, the prevalence of workers who had previously been exposed to occupational noise was 23%, 15%, and 9%, respectively. Hearing loss and tinnitus are common in the United States, particularly among noise-exposed workers [11].

1.1 Work Place Noise Standards

The occupational noise guidelines recommended by DGMS through circular number. 18 (Tech) in 1975 [12]:

- A warning limit of 85 dB (A) may be established as the level at which an eight-hour exposure poses minimal danger of hearing damage to an unprotected ear.
- The dangerous limit value must be set at 90 dB (A), over which the risk of hearing impairment and deafness from an exposed ear increase.
- An employee should not be permitted to come in a zone with a noise intensity of at least 115 decibels (A) without wearing suitable ear protection.
- Personal protection equipment must be worn if there are secluded noise bursts that may exceed 130 decibels
- "Impulse" or 120 decibels (A) "Fast." No employee is permitted to enter an area where the decibel level exceeds 140 (A).

The investigation indicated that the noise exposure in the research region of the mine is quite huge, with significant health consequences [5]. The noise generated by equipment used in mines would impact the operator operating it and also the person presents in vicinity. Impulsive sound is greater contributor to noise annoyance. Impact of noise can be categorised in three types as physical, psychological and physiological. Many research studies have been already done on topics like NIHL or other physical losses due to noise exposure in mines. But, the physiological and psychological aspects of problem in Indian mines have been rarely studied. Acoustic trauma has been less studied in Indian mines. Therefore, the research is intended to determine the noise level in the mines as well as to study its impact of noise on miner's health.

2 Methodology

The first stage will involve the measurement of equivalent sound level using EXTECH noise dosimeter model SL400 (Fig. 1). Then there will be proper set of questionnaires were asked to understand miner's health and acoustic trauma. Questionnaires will be intended to understand the daily lifestyle changes caused due to noise. Analysis of physical, physiological and psychological effects on miner's health.

The dosimeter is worn by the employee during the part of the shift. Some jobs have stable noise levels and may only require measurement for an hour or two [13]. In this study, the sample was taken for minimum of 2 h. Considering workers are doing work in repetitive cycles, equivalent sound level (Leq) for the sample duration was taken as a representative sample for full shift. For example, the operator running shearer machine spends most of the shift duration to operate the machine and tasks performed by the worker represent a typical shift. The measurement was long enough to account for the daily activities and changes in the acoustic environment experienced by the worker. The average noise level measured over the 2-h measurement period can be assumed to be equal to the worker's noise-exposure level (Leq,t = Lex(Noise exposure level for 8 h)) [13].

The employee wears the dosimeter for the whole or a portion of their working shift. The worker is not required to be accompanied by the individual in charge of noise measures throughout the duration of the noise survey. Nonetheless, if noise levels are excessive, the worker should maintain a diary comprising data about jobs accomplished, locations visited, and any other pertinent information. If a logging dosimeter is employed, any unobserved peaks in noise levels must also be extensively studied. The accuracy of

Fig. 1. Noise Dosimeter SL400

the noise measurements will rely on the worker's participation and the dosimeter's correct application.

Total of 14 mine workers were selected for the study. The 14 mine workers are 1 shearer operator (S.O), 1 driller, 1 road head operator (R.H.O), 1 bolter miner (B.M), 1 Belt Operator (B.O), 1 Belt fitter (B.F), 1 Load haul dumper (LHD) operator, 1 belt cleaner (B.C), 2 winder operators (W.O) one is of skip and other is of cage, 2 separate fan house operators (F.H.O), 2 separate compressor house operators (C.H.O). The NIHL questionnaire is shown in the Table 1 and a five pointer Likert scale was used for evaluation [14, 15]. The field data of the noise measured and the response of the NIHL questionnaire is shown in the Table 2.

3 Statistical Analysis

A correlation analysis and validity test for the noise and noise induced hearing loss questionnaire data respectively was conducted using IBM SPSS software version 25. The Cronbach alpha value of the all the questions is above 0.7 [16]. So, all questions were considered for the statistical analysis. The correlation between the noise and NIHL questionnaire is found to be 0.867. This shows a significant correlation between the both.

4 Conclusive Remarks

The study concludes that the mine employees are exposed to high noise which are higher than the recommended standards by the DGMS. The same is concluded through the noise induced hearing loss questionnaire. By the above evidence, it is mandatory to provide personal protective equipment for noise such as ear plugs and mine management has to take preventive measures for noise reduction by identifying the noise source.

Table 1. NIHL Questionnaire

Sl. No	NIHL Questionnaire
1	How often do you feel pain or discomfort in ear during or after the job
2	How often do you experience headache during work
3	Have you ever worn a hearing aid
4	How long have you had this roaring, yelling, or buzzing in your brain or ears
5	How problematic is this roaring, yelling, or buzzing in your brain or ears
6	How frequently do you struggle to keep up with a discussion if there is background noise, such as when others are speaking, or the television is on, or the youngsters are playing
7	Have you ever had previous ear surgery
8	Can you typically hear and comprehend what a speaker speaks without even seeing his or her face from across a silent room while speaking in a normal voice.
9	Have you had past ear infection, earaches, or drainage
10	How difficult it is for you to communicate during work
11	How often do you feel irritation due to sound at workplace
12	To what extent did you have trouble sleeping due to ear buzzing
13	To what extent noise are you having trouble concentrating or paying attention during work
14	How often you work for extra hours beyond your usual shift
15	Do you use Personal Protective Equipment for noise during work

Table 2. Field data

OCCUPANT	NOISE LEVEL (DBA)	Questionnaire data															
		Q-1	Q-2	Q-3	Q-4	Q-5	Q-6	Q-7	Q-8	Q-9	Q-10	Q-11	Q-12	Q-13	Q-14	Q-15	TOTAL
S.O	94.2 dB	3	2	2	1	2	1	2	5	2	4	3	2	2	3	1	35
DRILLER	96.7 dB	2	2	2	1	1	4	2	4	2	4	3	2	3	4	2	38
R.H.O	94.3 dB	3	2	2	2	2	1	2	4	2	5	3	1	2	1	2	34
B.M	94.7 dB	1	1	2	2	1	1	2	5	2	5	2	1	1	3	2	31
B.O	92.9 dB	2	2	2	1	2	1	2	5	2	3	2	2	1	4	1	32
B.F	86.7 dB	1	1	2	1	1	1	2	4	2	2	1	3	1	2	1	25
LHD OPERATOR	86.2 Db	1	2	2	1	1	1	2	5	2	2	1	1	1	1	2	25
B.C	87.4 dB	1	1	2	1	1	1	2	2	2	1	1	3	2	3	2	25
W.O 1	79.7 dB	1	1	2	1	1	1	2	4	2	3	2	1	1	1	1	24
W.O 2	87.9 dB	1	2	2	1	2	1	2	4	2	2	2	1	1	1	1	25
F.H.O 1	92.9 dB	2	3	2	4	2	4	2	4	1	2	3	1	2	1	3	36
F.H.O 2	94.7 dB	3	2	2	2	2	1	2	4	2	5	4	2	3	1	1	36
C.H.O 1	90.2 dB	3	2	2	1	2	3	2	4	2	3	3	1	2	3	2	35
C.H.O 2	95.3dB	2	2	2	1	2	3	2	5	2	4	2	2	2	3	1	35

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References

1. VijayaKumar, C. H., and HarshaVardhan Ch S N Murthy. "Noise Assessment in Mines–A Critical Review." Concurrent Advances in Mechanical Engineering 2.1 (2016). https://doi.org/10.18831/came/2016011002
2. Goines, L., & Hagler, L. (2007). Noise pollution: a modem plague. South Med J, 100(3), 287–94.
3. Uchida, Yasue, et al. "Age-related hearing loss and cognitive decline—The potential mechanisms linking the two." Auris Nasus Larynx 46.1 (2019): 1–9.
4. https://doi.org/10.1016/j.anl.2018.08.010
5. JJ Hannah Glick, Anu Sharma,Cross-modal plasticity in developmental and age-related hearing loss: Clinical implications, HearingResearch, Volume343,2017, Pages 191–201, ISSN:0378–5955, https://doi.org/10.1016/j.heares.2016.08.012
6. Assessment of equipment operator's noise exposure in western underground gold and silver mines-E.R. SPENCER (2009).
7. Baffoe, Peter Ekow, Alfred Allan Duker, and Efiba Vidda Senkyire-Kwarteng. "Assessment of health impacts of noise pollution in the Tarkwa Mining Community of Ghana using noise mapping techniques." Global Health Journal 6.1 (2022): 19–29.
8. https://doi.org/10.1016/j.glohj.2022.01.005
9. Li, Jing, et al. "A simulation experiment study to examine the effects of noise on miners' safety behavior in underground coal mines." BMC public health 21.1 (2021): 1–12. https://doi.org/10.1186/s12889-021-10354-2
10. Goswami, S., Swain, B.K. Environmental Noise in India: a Review. Curr Pollution Rep 3, 220–229 (2017). https://doi.org/10.1007/s40726-017-0062-8
11. Swain BK, Goswami S, Das M. A preliminary study on assessment of noise levels in Indian offices: a case study. Asian Journal of Water Environment and Pollution. 2014; 11(4):39–44.
12. Work Place Noise Standards DGMS Circular No.18 (Tech), 1975
13. Hermanus, M.A. (2007). Occupational health and safety in mining-status, new developments, and concern. The Journal of the Southern African Institute of Mining and Metallurgy, 107, 531–538
14. Masterson, E.A., Themann, C.L., Luckhaupt, S.E., Li, J. and Calvert, G.M. (2016), Hearing difficulty and tinnitus among U.S. workers and non-workers in 2007. Am. J. Ind. Med., 59: 290–300. https://doi.org/10.1002/ajim.22565.
15. Measuring Occupational Noise-How to do noise surveys, calculate exposure to noise, and analyze and report the result ISBN 978–0–7726–7857–7 © 2019 Workers' Compensation Board (WorkSafeBC).
16. https://wwwn.cdc.gov/nchs/data/nhanes/2011-2012/questionnaires/aug.odf