HEARING IMPAIRMENT AMONG WORKERS EXPOSED TO EXCESSIVE LEVELS OF NOISE IN INDIAN STEEL INDUSTRIES -A PROSPECTIVE CROSS-SECTIONAL COMPARATIVE STUDY

Athira Krishnan[1], Shirin Haris[1], Shibi Mary Thomas[2], Balakeshawa Ramaiah[3]

Pharm.D intern[1], M. Pharm, PhD Assistant Professor[2], M.Pharm, PhD, HOD Pharmacy Practice[3]
Department of Pharmacy Practice, Karnataka College Of Pharmacy, Bengaluru, Karnataka-560064

ABSTRACT

One of the most significant occupational concerns is noise-induced hearing loss, which is an irreversible but treatable condition. Industrial employees in developing nations are affected by occupational noise exposure, which is the second-most commonly self-reported occupational injury. The aim was to determine the extent and impact of noise induced hearing impairment on steel industry workers and to educate on the need to use preventive measures. In this study, demographic details of the steel industry workers were collected and they were interviewed using a pre-structured questionnaire and analyzed. The workers were educated on the need to use preventive measures and protective aids. The hearing potential was analyzed using chi-square test (social science statistics) significance at p-value 0.05. Workers in older age group, with working experience of 21-30 years and working duration of 11-13 hours showed positive association with hearing impairment. Workers using preventive measures had lesser incidence of hearing impairment when compared to the workers not using preventive measures. From the study, it can be concluded that age, working hours and working experience were the contributing factors to hearing impairment among the steel industry workers. This study also helped to analyze the need for using proper preventive measures for better efficacy.

Keywords: Noise Induced Hearing Loss (NIHL), Preventive measures, Steel industries, Working experience, Age, Duration of noise exposure, sensorineural, ear.

INTRODUCTION

Any undesirable disturbance that occurs within a suitable frequency band is called noise. Noise can be divided into two categories: occupational noise and environmental noise based on how it affects people's health. In the world, industrial noise is responsible for 16% of adults with a disabling hearing impairment [2]. Permanent sensorineural hearing loss brought on by persistent exposure to loud noises is known as noise- induced hearing loss [6]. There are numerous causes that can lead to hearing loss, such as exposure to loud noises (professionally and recreationally), persistent ear infections, and ototoxicity (especially iatrogenic ototoxicity) [1]. The term hearing impairment is a binaural average hearing threshold of greater than 25dB hearing loss over frequencies between 1 and 4 kHz [6].

It results from exposure to excessive sound levels or prolonged durations that harm the cochlea's hair cells, and by the time it manifests as a noticeable impairment, it may already be advanced [7]. Temporary threshold shift are the two forms of inner ear injuries that can arise from noise stress, depending on the intensity and length of the exposure [4]. Recent studies have shown that many factors, including noise, ageing, organic solvents, heavy metals, smoking, hypertension and hyperlipidemia are linked to hearing loss at work. Due to the sort of production process and the equipment utilized, steel companies produce excessive noise [3]. An acceptable exposure limit for occupational noise exposure is 85dB, measured as an 8-hour time weighed average (8-hr TWA), according to the National Institute for Occupational Safety and Health (NIOSH). Hazardous noise exposures are those at and above this intensity [2]. Acoustic impulses entering the auditory system through the external ear canal, pinna and outer ear are the first step in the pathophysiology of NIHL. At high frequencies of around 2,000 Hz, this funnel creates resonance, which increases the energy (heard as high pitches).

The vibration of three tiny bones known as the ossicles allow the energy to pass through the middle ear and reach the eardrum. The cochlea, which is the inner ear and contains a chamber filled with fluid inside the skull, receives vibrations that have been amplified by the eardrum and ossicles and carries them there. Loud noises can produce spasms in the middle ear, which can reduce these vibrations [8].

The upper sections of the hair cells are stimulated by vibration from the middle to inner ear, which produces motion and chemical changes that result in nerve impulse production. The auditory nerve carries these nerve impulses to the brain, where they are translated into sound.The inner ear (cochlea)is especially vulnerable to damage from loud sounds. The cochlea's hair cells are unique sensory cells that can both detect and endure very loud sounds. The damage caused to them is permanent and irrevocable [8].

The prevalence of hearing loss among employees will decrease with the execution of hearing conservation programs in workplace settings. Effective ways to lessen the likelihood of occupational hearing loss include lowering noise levels, strengthening restrictions, and using appropriate protective equipment [1]. When engineering controls and work procedures are ineffective for decreasing noise exposure to permissible levels, hearing protection should be utilized. A hearing protection device (HPD) is a tool used to lower the volume of sound that penetrates the eardrum. There are several distinct styles of hearing protection devices including ear muffs, ear plugs, and ear canal covers [5]. The hearing protection devices' average reduction in sound level is shown

by the noise reduction rating. The conventional hearing protectors have a noise reduction rating that ranges from nearly 0 to 30. A higher range indicates that the HPDs are more effective.
Since the Employees State Insurance Act of 1948 and the Workmen's Compensation Act came into effect in India, NIHL has been recognized as a sickness that is eligible for compensation (1923). However, very few individuals are still aware of this fact [5]. Therefore, the purpose of this study is to determine the extent and impact of noise induced hearing impairment on steel industry workers by identifying the confounding factors and to adequately educate and enhance workers' knowledge so that they would understand the critical significance of wearing hearing protectors.

METHOD

This present study used a prospective cross-sectional comparative study design which was conducted in 11 Indian steel industries from February to July 2021. After taking consent from the reverent authorities, a face- to- face interview was conducted among 165 male workers with a pre-structured questionnaire. The data collection using the set of questionnaires included the demographic details, the knowledge towards noise induced hearing impairment and other relevant information about the steel industry workers. A comparative analysis was conducted to estimate the rate of hearing impairment among workers with and without the use of preventive measures. The obtained data was statistically analyzed by chi-square test using social science statistics with significance level at $p<0.05$.

Ethical considerations:

Orally informed consent was taken from workers before enrollment. Workers were made aware that their participation is voluntary and they can decide not to take part without any adverse influence on their daily routine. Privacy and confidentiality of the research participants will be protected.

Result:

Table 1
Age group distribution of workers with hearing impairment

	Age (in years)				
	21-30	31-40	41-50	51-60	Row total
Hearing impairment	4 (5.6%)	12 (27.9%)	8 (29.6%)	12(52.2%)	36 (21.8%)
No Hearing impairment	68 (94.4%)	31 (72.1%)	19 (70.4%)	11(47.8%)	129 (78.2%)
Column total	72	43	27	23	165 (Grand Total)

The chi-square statistics is 25.4883. The p-value is 0.000012. The result is significant at $p<0.05$.

Table 2
Exposure duration and no. of workers with hearing impairment enrolled in the study

	Duration of exposure (in hours)			
	5-7	8-10	11-13	Row total
Hearing impairment	1(2.3%)	18 (26.5%)	17 (31.5%)	36 (21.8%)
No Hearing impairment	42 (97.7%)	50 (73.5%)	37 (68.5%)	129(78.2%)
Column total	43	68	54	165 (Grand Total)

The chi-square statistics is 13.3972. The p-value is 0.001233. The result is significant at $p<0.05$.

Table 3
Working experience and no. of the workers with hearing impairment enrolled in the study.

	Working Experience (in years)			
	0-10	11-20	21-30	Row total
Hearing impairment	6 (5.8%)	17 (42.5%)	13 (59.1%)	36 (21.8%)
No Hearing impairment	97 (94.2%)	23 (57.5%)	9 (40.9%)	129 (78.2%)
Column total	103	40	22	165 (Grand Total)

The chi-square statistics is 25.7183. The p-value is <0.00001. The result is significant at $p<0.05$.

Table 4
Comparison of hearing impairment among steel industry workers with or without using preventive measures.

	Preventive measures	No Preventive measures	Row total
Hearing impairment	2 (4.3%)	34 (28.6%)	36 (21.8%)
No hearing impairment	44 (95.7%)	85 (71.4%)	129 (78.2%)
Column Totals	46	119	165 (Grand Total)

The chi-square statistics is 11.4123. The p-value is 0.00073. The result is significant at $p<0.05$.

Discussion:

The only type of hearing loss that is entirely preventable is NIHL, but it continues to be a serious health issue in south east Asian nations with negative economic repercussions [10]. Young employees were the key contributors in the production sector of the majority of steel industry, in accordance with the nature of labor demanding employment [19].

One of the most common causes of high frequency hearing loss was presbycusis and its effects started to manifest around the age of forty [10]. According to this study, employees who were 31 years of age and older had a five folds higher chance of having hearing impairment that those who were under 31 years of age. As the age progresses, the hearing impairment in elderly workers appears to worsen (table 1). Similar findings were seen in other study conducted by Aung. K. Zaw et.al where they studied assessment of noise exposure and hearing loss among workers in a textile mill [2]. Johansson and Arlinger also reported a strong association between hearing threshold level [HTL] and age. They also showed that HTL'S increased more rapidly in those aged over 50years [11].

The American Conference of Governmental Industrial Hygienists recommended an industry standard for a noise exposure level of 85dB for 8hours of work as the cutoff value to protect the workers from hearing loss [12]. As indicated in table 2, the chi-squared test demonstrated that hearing impairment had strong association with duration of noise exposure. These findings are consistent with those of the study by Chai et.al., who assessed individual noise exposure at a steel cold rolling factory. According to those findings all the participant groups were exposed to noise levels of at least 85dB. These data might indicate that steel employees were subjected to excessive noise levels which they were working [13].

This current study found that when the amount of time spent being exposed to excessive noise grew, NIHL prevalence increased as well. In people with 0-10 years of work experience, the prevalence of hearing impairment was 5.83%, whereas 21-30 years of experience had a prevalence of 59.09% (Table 3). This concludes that working experience is directly proportional to the hearing impairment. This trend resembles a study conducted in the United States which discovered the prevalence of NIHL was 75% for workers with 20-29 years of experience and 100% for workers with over 40 years of experience in the construction industry [14].

The impact of work experience on hearing threshold has already been noted by researchers. According to research by Celik et.al., employees of a hydroelectric power plant exhibit hearing loss within the first 10 years of noise exposure and there is a little advancement in the years [15]. The hearing loss caused by continuous noise, according to Taylor, for long term exposure of fewer than 10 years [16]. Similar results were found in Lakwinder Pal Singh study which showed that workers expose to noise at work for longer period of time (10-15 years) suffered more serious hearing impairment than those exposed for shorter periods of time (up to 5 years) [17].

Hearing protection devices help ameliorate industrial impulsive noise, but they cannot preclude workers from developing advanced hearing loss [18]. It is plausible to infer that the properties required for ear protectors to protect auditory from abrupt noise differ from those required to protect against the continuous noise. When engineering controls and works procedures were not practical, hearing protectors like earmuffs, ear plugs and ear canal covers should be used to alleviate noise exposure to safe levels. In the current research, the majority of employees had hearing impairment (Table 4) as they did not wear any hearing protection devices (HPD) at work place. It may be postulated that the employees' knowledge of NIHL and their use of HPDs as self-protective measures at work were underwhelming. Based on research by Hong, at the higher, more sensitive noise frequencies of 4kHz and 6kHz, nearly 60% of workers had hearing loss. According to that study, HPDs were reportedly used on average for 48% of the period that was specified for their use. HPD use and hearing loss at higher frequencies were found to be significantly inversely correlated (4-6kHz) [20].

Conclusion:

Excessive workplace noise exposure is a problem for steel industry workers in India, the majority of the workers were not been protected from occupational NIHL. In conclusion, from this study, working hours and working experience were the contributing factors to hearing impairment among the steel industry workers. In which, age, working experience and hearing impairment are directly proportional to each other that is workers in the age group of 51-60 years had a greater extent of hearing impairment compared to other age groups and as working experience increases the occurrence of hearing impairment was high. There was a strong association between working hours and the exposure to high frequency noise which resulted in hearing impairment among steel industry workers. This study indicated that preventive measures can reduce the incidence of hearing impairment. Hence, hearing conservative program should be implemented by the authorities of the industries for effective preventions and control of hearing loss when the workers are exposed to high frequency of noise.

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