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Original Article

Clinical and Audiological Profile of Occupational Noise-Induced Hearing Loss in Industrial Workers / Drivers

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ABSTRACT

Introduction: Occupational noise-induced hearing loss (NIHL) is one of the most common preventable sensory impairments among industrial workers and professional drivers exposed to chronic high-intensity noise. Prolonged exposure leads to irreversible cochlear damage, resulting in progressive sensorineural hearing loss. Early detection through clinical and audiological evaluation is essential to prevent disability and improve occupational health outcomes.
Aims: To evaluate the clinical and audiological profile of occupational noise-induced hearing loss among industrial workers and drivers, and to assess the pattern, severity, and risk factors associated with hearing impairment in this population.
Materials and Methods: The present study was designed as a hospital-based cross-sectional observational study conducted in the Department of Otorhinolaryngology (ENT). The study was carried out over a period of 12 months and included industrial workers and professional drivers with a history of chronic occupational noise exposure attending the ENT outpatient department. A total of 80 patients fulfilling the inclusion criteria were enrolled in the study as the sample size.
Results: The duration of noise exposure among the study patients s showed that in Group A (industrial workers), 12 patients (30%) had 5–10 years of exposure, 20 patients (50%) had 11–20 years of exposure, and 8 patients (20%) had more than 20 years of exposure. In Group B (drivers), 18 patients (45%) had 5–10 years of exposure, 15 patients (37.5%) had 11–20 years of exposure, and 7 patients (17.5%) had more than 20 years of exposure. In the two groups, the difference in duration of exposure was found to be statistically not significant, with a p-value of 0.34.
Conclusion: Occupational noise exposure remains a significant risk factor for sensorineural hearing loss among industrial workers and drivers. Regular audiometric screening, enforcement of occupational safety measures, and use of personal protective devices are essential to reduce the burden of NIHL.

Keywords*:* Noise-induced hearing loss, occupational exposure, industrial workers, drivers, pure tone audiometry, sensorineural hearing loss.

INTRODUCTION

Noise-induced hearing loss (NIHL) is a significant and entirely preventable occupational health problem that continues to affect millions of workers worldwide, particularly those employed in high-noise environments such as industries, manufacturing units, construction sites, mining sectors, and transportation services. It is characterized by a permanent, bilateral, and sensorineural hearing impairment resulting from prolonged exposure to hazardous levels of noise. Unlike conductive hearing loss, NIHL primarily involves damage to the cochlear hair cells, especially the outer hair cells of the organ of Corti, leading to irreversible auditory dysfunction. With increasing industrialization and urbanization, occupational noise exposure has emerged as a major contributor to adult-onset hearing impairment, making it an important public health concern [1,2].

The World Health Organization (WHO) estimates that over 16% of disabling hearing loss in adults is attributable to occupational noise exposure, highlighting its global burden [3]. Industrial workers operating heavy machinery and professional drivers exposed to engine noise, traffic congestion, and urban sound pollution are particularly vulnerable groups. Continuous exposure to noise levels exceeding 85 dB for prolonged durations significantly increases the risk of cochlear damage. The damage initially manifests as a temporary threshold shift, which may recover partially, but repeated exposure leads to permanent threshold shift, resulting in progressive hearing impairment [4].

The pathophysiology of NIHL involves metabolic exhaustion and mechanical injury to cochlear hair cells due to excessive stimulation. Noise exposure leads to the generation of reactive oxygen species (ROS), resulting in oxidative stress, mitochondrial damage, and eventual apoptosis of hair cells. The basal turn of the cochlea, which is responsible for high-frequency sound perception, is most commonly affected. This explains the characteristic audiometric "notch" at 3–6 kHz observed in early NIHL cases [5]. Over time, the hearing loss may progress to involve speech frequencies, significantly affecting communication, social interaction, and quality of life.

Industrial workers in sectors such as steel manufacturing, textile mills, cement factories, and automotive production are routinely exposed to high decibel noise generated by machinery and equipment. Similarly, drivers of heavy vehicles, buses, and taxis experience prolonged exposure to engine vibrations and traffic noise, often without adequate hearing protection. Despite regulations and occupational safety standards, compliance with the use of personal protective equipment (PPE), such as earplugs and earmuffs, remains suboptimal in many developing regions [6].

Audiological assessment, particularly pure tone audiometry (PTA), remains the gold standard for diagnosing NIHL. Early detection through regular screening programs can identify temporary threshold shifts and prevent progression to permanent hearing damage. However, in many occupational settings, routine hearing evaluations are not consistently implemented, leading to delayed diagnosis and irreversible impairment [7]. In addition to hearing loss, affected individuals may also experience tinnitus, difficulty in speech discrimination, and reduced work efficiency, which collectively impact occupational productivity and safety.

Preventive strategies for NIHL focus on three major approaches: engineering controls (noise reduction at source), administrative controls (limiting exposure duration), and personal protective measures (use of hearing protection devices). Education and awareness programs play a crucial role in improving compliance among workers. Despite advancements in occupational health policies, NIHL continues to be underdiagnosed and undertreated, particularly in low- and middle-income countries where industrial safety regulations are not strictly enforced [8].

Drivers represent a unique subgroup of occupational exposure due to prolonged hours in high-traffic environments. Continuous exposure to engine noise, honking, and urban sound pollution contributes significantly to cumulative auditory damage. Studies have shown that professional drivers exhibit early high-frequency hearing loss, often unnoticed until significant impairment occurs [9]. This highlights the importance of periodic audiological evaluation not only in industrial workers but also in transportation workers.

Given the irreversible nature of NIHL, emphasis must be placed on early identification, preventive strategies, and strict implementation of occupational safety standards. The present study aims to evaluate the clinical and audiological profile of occupational noise-induced hearing loss among industrial workers and drivers, thereby contributing to better understanding, early detection, and prevention of this largely avoidable condition [10].

The aim of the present study is to evaluate the clinical and audiological profile of occupational noise-induced hearing loss (NIHL) among industrial workers and drivers exposed to chronic occupational noise. The study seeks to identify the pattern, type, and severity of hearing impairment in these high-risk groups using clinical evaluation and pure tone audiometry, and to assess the relationship between duration of exposure, occupational category, and degree of hearing loss. The objective is also to highlight early audiological changes associated with noise exposure, thereby aiding in early diagnosis and prevention of progression to permanent hearing impairment.

MATERIALS AND METHODS

Study Design: This study was designed as a hospital-based cross-sectional observational study

Study Place: The study was conducted in the Department of Otorhinolaryngology (ENT), IPGMER, SSKMH, Kolkata.

Study Duration: The study was carried out over a period of 12 months.

Study Population: The study population included industrial workers and professional drivers with a history of chronic occupational noise exposure attending the ENT outpatient departmen**t.**

Sample Size: A total of 80 patients

Study variables:

- Age Distribution
- Sex Distribution
- Duration of Noise Exposure
- Degree of Hearing Loss (PTA Findings)
- Use of Hearing Protection Devices (HPD)

Inclusion Criteria: Subjects aged 18–60 years with a minimum of 5 years of occupational exposure to high-intensity noise (industrial workers and drivers), who consented to participate in the study and underwent audiological evaluation.

Exclusion Criteria : Individuals with pre-existing congenital hearing loss, history of chronic otitis media, ototoxic drug intake, head injury affecting hearing, systemic diseases known to cause hearing impairment, and those unwilling to participate were excluded from the study.

Statistical Analysis:

For statistical analysis data were entered into a Microsoft excel spreadsheet and then analyzed by SPSS (version 27.0; SPSS Inc., Chicago, IL, USA) and GraphPad Prism version 5. Data had been summarized as mean and standard deviation for numerical variables and count and percentages for categorical variables. Two-sample t-tests for a difference in mean involved independent samples or unpaired samples. Paired t-tests were a form of blocking and had greater power than unpaired tests. A chi-squared test ($\chi 2$ test) was any statistical hypothesis test wherein the sampling distribution of the test statistic is a chi-squared distribution when the null hypothesis is true. Without other qualification, 'chi-squared test' often is used as short for Pearson's chi-squared test. Unpaired proportions were compared by Chi-square test or Fischer's exact test, as appropriate.

Explicit expressions that can be used to carry out various t-tests are given below. In each case, the formula for a test statistic that either exactly follows or closely approximates a t-distribution under the null hypothesis is given. Also, the appropriate degrees of freedom are given in each case. Each of these statistics can be used to carry out either a one-tailed test or a two-tailed test.

Once a t value is determined, a p-value can be found using a table of values from Student's t-distribution .If the calculated p-value is below the threshold chosen for statistical significance (usually the 0.10, the 0.05, or 0.01 level), then the null hypothesis is rejected in favour of the alternative hypothesis.
P-value ≤ 0.05 was considered for statistically significant.

RESULT

Table 1: Age Distribution among Study Groups

Age Group (years)	Group A (n=40)	Group B (n=40)	Total (n=80)	P value
18–30	10 (25%)	12 (30%)	22 (27.5%)	0.81
31–45	18 (45%)	16 (40%)	34 (42.5%)	
46–60	12 (30%)	12 (30%)	24 (30%)	
Total	40 (100%)	40 (100%)	80 (100%)	

Table 2: Gender Distribution among Study Groups

Gender	Group A (n=40)	Group B (n=40)	Total (n=80)	P value
Male	32 (80%)	35 (87.5%)	67 (83.75%)	0.39
Female	8 (20%)	5 (12.5%)	13 (16.25%)	
Total	40 (100%)	40 (100%)	80 (100%)	

Table 3: Duration of Noise Exposure

Duration (years)	Group A (n=40)	Group B (n=40)	Total (n=80)	P value
5–10 years	12 (30%)	18 (45%)	30 (37.5%)	0.34
11–20 years	20 (50%)	15 (37.5%)	35 (43.75%)	
>20 years	8 (20%)	7 (17.5%)	15 (18.75%)	
Total	40 (100%)	40 (100%)	80 (100%)	

Table 4: Degree of Hearing Loss (PTA Findings)

Severity	Group A (n=40)	Group B (n=40)	Total (n=80)	P value
Normal	8 (20%)	10 (25%)	18 (22.5%)	0.73
Mild	14 (35%)	16 (40%)	30 (37.5%)	
Moderate	12 (30%)	10 (25%)	22 (27.5%)	
Severe	6 (15%)	4 (10%)	10 (12.5%)	
Total	40 (100%)	40 (100%)	80 (100%)	

Table 5: Use of Hearing Protection Devices (HPD)

HPD Use	Group A (n=40)	Group B (n=40)	Total (n=80)	P value
Yes	10 (25%)	8 (20%)	18 (22.5%)	0.59
No	30 (75%)	32 (80%)	62 (77.5%)	
Total	40 (100%)	40 (100%)	80 (100%)	

Figure 1 : Duration of Noise Exposure

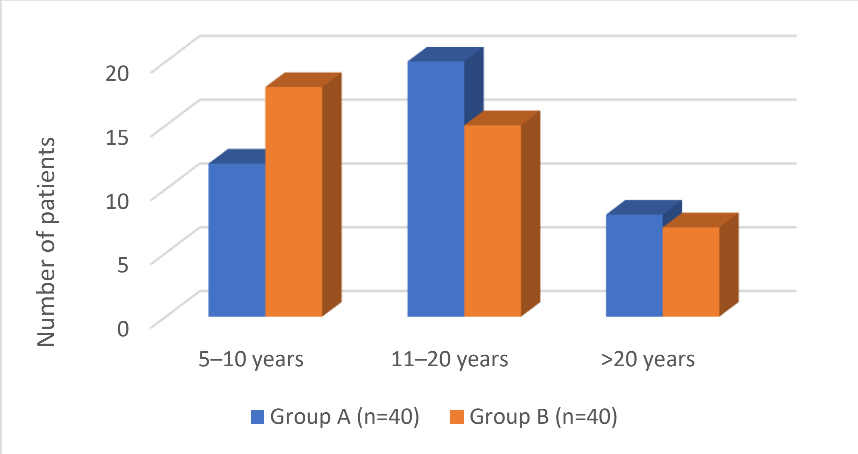
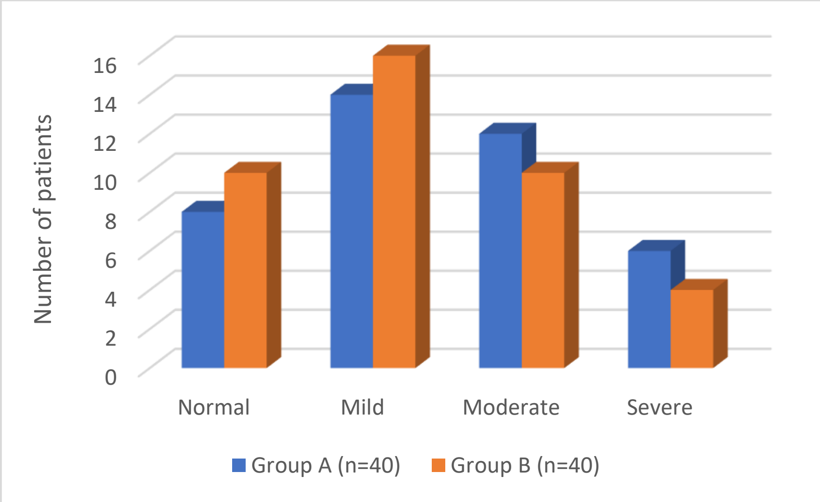


Figure 2 : Degree of Hearing Loss (PTA Findings)



The age distribution among the study patients showed that in Group A (industrial workers), 10 patients (25%) were in the 18–30 years age group, 18 patients (45%) were in the 31–45 years group, and 12 patients (30%) were in the 46–60 years group. In Group B (drivers), 12 patients (30%) belonged to the 18–30 years age group, 16 patients (40%) were in the 31–45 years group, and 12 patients (30%) were in the 46–60 years group. The comparison between the two groups revealed no statistically significant difference in age distribution, with a p-value of 0.81.

The gender distribution among the study patients showed that in Group A (industrial workers), 32 patients (80%) were males and 8 patients (20%) were females. In Group B (drivers), 35 patients (87.5%) were males and 5 patients (12.5%) were females. In the two groups, there was no significant difference in gender distribution, with a p-value of 0.39.

The duration of noise exposure among the study patients s showed that in Group A (industrial workers), 12 patients (30%) had 5–10 years of exposure, 20 patients (50%) had 11–20 years of exposure, and 8 patients (20%) had more than 20 years of exposure. In Group B (drivers), 18 patients (45%) had 5–10 years of exposure, 15 patients (37.5%) had 11–20 years of exposure, and 7 patients (17.5%) had more than 20 years of exposure. In the two groups, the difference in duration of exposure was found to be statistically not significant, with a p-value of 0.34.

The severity of hearing loss among the study patients showed that in Group A (industrial workers), 8 patients (20%) had normal hearing, 14 patients (35%) had mild hearing loss, 12 patients (30%) had moderate hearing loss, and 6 patients (15%) had severe hearing loss. In Group B (drivers), 10 patients (25%) had normal hearing, 16 patients (40%) had mild hearing loss, 10 patients (25%) had moderate hearing loss, and 4 patients (10%) had severe hearing loss. In the two groups , the two groups, the difference in severity of hearing loss was found to be statistically not significant, with a p-value of 0.73.

The use of hearing protection devices (HPD) among the study participants showed that in Group A (industrial workers), 10 patients (25%) using HPD while 30 patients (75%) did not use any hearing protection. In Group B (drivers), 8 patients (20%) using HPD and 32 patients (80%) did not use any protective devices. In the two groups, the difference in HPD usage was found to be statistically not significant, with a p-value of 0.59.

DISCUSSION

The age distribution in the present study showed that the majority of participants were in the 31–45 years age group in both groups, reflecting the working-age population most commonly exposed to occupational noise. Similar findings were reported by Themann CL et al. [11], who highlighted that NIHL predominantly affects economically productive age groups due to prolonged occupational exposure . Chang TY et al [12] also emphasized that middle-aged workers are particularly vulnerable as cumulative noise exposure increases with duration of employment .

In terms of gender distribution, the present study showed male predominance in both groups. This finding is consistent with Eng A et al. , who reported that occupational noise exposure is significantly higher among males due to their higher representation in industrial and transport sectors [13]. Melamed S et al also noted that male workers are more frequently engaged in high-risk noisy occupations compared to females, which explains the observed distribution [14].

The duration of noise exposure was mostly between 5–20 years in both groups, and no significant difference was noted between industrial workers and drivers. Passchier-Vermeer W reported that continuous exposure above 85 dB for more than 10 years significantly increases the risk of permanent threshold shift in hearing [15]. Similarly, Singh LP et al observed in Indian industrial settings that longer duration of exposure correlates strongly with severity of hearing loss, particularly in textile and metal industries [16].

In the present study, pure tone audiometry revealed that most participants had mild to moderate sensorineural hearing loss, with a characteristic high-frequency involvement. This pattern is consistent with the classical "4 kHz notch" described in NIHL. Stelmachowicz PG et al reported that early NIHL typically affects high frequencies (3–6 kHz) before progressing to speech frequencies [17]. Shi L further explained that cochlear synaptopathy due to noise exposure leads to early hidden hearing loss even before significant threshold shifts are detected clinically [18].

The severity of hearing loss did not differ significantly between industrial workers and drivers in the present study. This is in agreement with Izadi N, who reported that professional drivers are also at high risk of NIHL due to continuous exposure to engine noise, traffic congestion, and urban sound pollution [19].

Regarding the use of hearing protection devices (HPD), only a small proportion of participants in both groups reported regular usage, with the majority not using any protective measures. This finding is consistent with Khoza-Shangase K who highlighted poor compliance with hearing protection in occupational settings, particularly in developing countries [20]. low awareness and poor implementation of protective strategies among Indian industrial workers, contributing to higher prevalence of NIHL .

CONCLUSION

The present study demonstrated that occupational noise exposure is an important risk factor for hearing impairment among industrial workers and professional drivers. Most participants exhibited mild to moderate sensorineural hearing loss with predominant high-frequency involvement, which is characteristic of noise-induced hearing loss (NIHL). The severity of hearing loss was found to increase with longer duration of occupational noise exposure. Although both groups showed comparable clinical and audiological profiles, inadequate use of hearing protection devices was observed among the majority of participants. These findings highlight the importance of regular audiological screening, early diagnosis, awareness regarding occupational hazards, and strict implementation of hearing conservation measures to prevent progression of irreversible hearing loss among noise-exposed workers.

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