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Research Article

Audiological Findings in Airport Loaders, & Railway Workshop Employees and their Opinion on Hearing Protective Devices - A Comparative Study

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Abstract

Background: Occupational noise exposure is a major risk factor for noise-induced hearing loss and remains a significant public health concern. Workers in high-noise environments such as airports and railway workshops are particularly vulnerable to auditory damage, which may adversely affect communication, work efficiency, and quality of life.

Aim/Purpose: The present study aimed to assess and compare the hearing status of airport loaders and railway workshop (E.M.U.) employees and to examine the association between occupational noise exposure and hearing loss.

Materials and Methods: A comparative cross-sectional study was conducted among airport loaders and railway workshop (E.M.U.) employees. All participants underwent detailed case history, otoscopic examination, and pure-tone audiometry. Hearing thresholds were analyzed to categorize participants as having normal hearing sensitivity or hearing loss. Statistical analysis was performed to evaluate the relationship between occupational noise exposure and hearing impairment.

Results: Among airport loaders, 76.66% demonstrated normal hearing sensitivity, while 23.33% showed hearing loss. In contrast, only 40% of railway workshop (E.M.U.) employees exhibited normal hearing sensitivity, whereas 60% had hearing loss. Statistical analysis revealed a significant correlation between occupational noise exposure and hearing loss, leading to rejection of the null hypothesis.

Conclusion: Occupational noise exposure was found to have a significant adverse effect on hearing sensitivity, with railway workshop (E.M.U.) employees exhibiting a higher prevalence of hearing loss compared to airport loaders. The findings underscore the importance of routine audiological monitoring, implementation of effective hearing conservation programs, and enforcement of noise control measures in high-risk occupational environments.

Keywords: (MeSH); Noise-Induced Hearing Loss; Occupational Noise; Hearing Disorders; Audiometry; Occupational Exposure

Abbreviations

NIHL: Noise-Induced Hearing Loss; ICF: International Classification of Functioning, Disability and Health (WHO, 2004); PTS: Permanent Threshold Shift; E.M.U.: Electric Multiple Unit (Railway Workshop Division); ASHA: American Speech-Language-Hearing Association; dB(A): A-weighted Decibel; HPD: Hearing Protective Device; WHO: World Health Organization; PTA: Pure-Tone Audiometry; SPL: Sound Pressure Level; OHS: Occupational Health and Safety; HCP: Hearing Conservation Program

Introduction

Hearing is a critical sensory function that enables communication, environmental awareness, and participation in daily activities. Although humans possess less acute auditory abilities than many animals, hearing remains essential for safety and social interaction. Modern industrialization and urbanization have intensified environmental noise exposure to levels that increasingly threaten auditory health, making noise pollution one of the most widespread environmental hazards worldwide [33].

Noise-Induced Hearing Loss (NIHL) is one of the most common preventable occupational disorders worldwide. It results from prolonged exposure to excessive sound levels, typically above 85 dB(A), and is characterized by either temporary threshold shifts or irreversible permanent threshold shifts [4,23]. In addition to auditory damage, chronic noise exposure can cause sleep disturbances, cardiovascular changes, stress, impaired concentration, reduced work efficiency, and broader psychosocial consequences [7,25].

Transportation sectors—particularly aviation and railway industries—are identified as high-risk environments for NIHL. Airport loaders are exposed to intense noise generated by aircraft engines, ground equipment, and loading machinery, often exceeding 100 dB(A) [1,2,15]. Railway workshop employees, especially those working in Electric Multiple Unit (E.M.U.) maintenance divisions, encounter continuous mechanical noise from metal fabrication tools, compressors, engines, and heavy machinery [13,19,29]. Despite well-established regulations and the availability of hearing protective devices (HPDs), awareness and compliance among workers remain inconsistent in many developing countries [20,32].

In India, occupational noise hazards are under-reported, and systematic noise surveys are limited. Although legislation exists for industrial noise control, implementation is inconsistent, particularly in unmonitored sectors such as airport ground staff and railway workshops. Consequently, workers remain vulnerable to preventable forms of hearing loss, often without adequate protective measures or hearing conservation programs [31].

Given these gaps, it is essential to assess the hearing status of workers exposed to high noise levels and to understand the factors contributing to NIHL, including age, duration of exposure, and use of protective devices. Age-related susceptibility and combined noise exposure have shown strong associations with progressive hearing decline [22,27]. Additionally, evaluating the impact of hearing loss on activity and participation through the International Classification of Functioning, Disability and Health (ICF) framework provides a broader understanding of its functional implications.

The present study aims to compare the audiological findings of airport loaders and railway workshop (E.M.U.) employees, analyze the influence of occupational noise exposure on hearing sensitivity, document workers' opinions on HPDs, and assess activity and participation limitations. Findings from this study are expected to support improved occupational health practices and contribute to the development of comprehensive hearing conservation programs in India.

Materials and Methods

The present study was conducted with the aim of documenting the audiological profile of airport loaders and railway workshop (E.M.U.) employees and their opinion on the hearing protective devices. This chapter discusses the subjects included in the study, subject selection criteria, the tools used, the test protocol, and the procedure followed to collect the data and the statistical analysis done.

Informed consent

All the test procedures were explained to the airport loaders and railway workshop (E.M.U.) employees and their written consents were obtained.

Subjects

A total of 60 male subjects i.e. 30 each for airport loaders and railway workshop (E.M.U.) employees were chosen for the study.

Subjects selection criteria:-

- **Age range:** Subjects between 25 to 40 years were chosen as participants for the study.
- **Work experience:** Employed workers with minimum 5 years of experience with continuous exposure of noise for an 8 hours/day at airport and railway workshop (E.M.U.) were chosen to study the impact of noise on hearing.

Only male workers were included in this study.

Subject exclusion criteria:-

- History of any hearing loss
- History of ear discharge.
- History of congenital malformations of ear canal.
- Familial history of hearing loss.
- History of Neurological contra-indication
- History of systemic, toxemic disease (hypertension, diabetes, smoking and caffeine consumption)
- History of exposure to noise other than from work place.
- History of administrating of ototoxic drugs.

All these details were collected from their medical and family history.

Tools

- Case history/demographic details were taken.
- Otoscope (Welch-Allyn incorporation) was used for clearance of workers with ear wax, infection, discharge etc.
- Calibrated single channel Pure Tone Audiometer (Elkon 3N3) was used to find out hearing sensitivity of each subject in each age group.
- Simple sound level meter for noise survey or noise mapping.
- Questionnaire of opinion of the subjects on the hearing protective devices.
- ICF (International Classification of Functioning, Disability and Health by WHO, 2004) was used to assess the activities and participation of workers
- For the purpose of this study items from Activities and Participation domains of ICF was used. This domain consists of nine sub-categories.
- Following items identified from Interpersonal interaction and relationship section was used:
- General interpersonal interactions.
- Particular interpersonal relationships like social relationship, family relationship, intimate relationship.
- Community, social and civic life
- Others
- The audiological evaluation was carried out in sound treated room meeting the ANSI (S3.91) Standards of permissible ambient noise levels in sound treated room.

Test protocol:-

The test protocol was as follows:

- **Client consent for participation in the study:** Informed consent from the participants was taken using the consent form which explained the purpose of the study and the procedures and the test involved. It also contained information regarding the confidentiality of the data and the participants and the personal data being used solely for the study purposes.
- **Demographic details:** The participant's age, sex, number of years of experience at the airport and railway workshop (E.M.U.), medical and family history and other significant details were recorded in this section.
- A field tested questionnaire to document the views of the workers on the hearing protective devices was administered which also explained the participants declaration of the duration of the noise exposure each day, status of the noise pollution, temporary threshold shift etc.

- Otoscopic examination of airport loaders and railway workshop employees was performed to examine any abnormality in the external auditory canal and the tympanic membrane. Subjects found with any abnormality were excluded from the study.
- **Pure tone audiometry:** The audiological evaluation was carried out for both air and bone conduction at octave frequencies from 250 to 8khz in both ears in a sound treated room meeting the ANSI (S3.91) Standards of permissible ambient noise levels in sound treated room (PTA2 was considered). Audiological evaluation was done after working hours and after providing sufficient rest period of 12 hours as recommended the national institute for occupational safety and health (NIOSH) to avoid the effect of temporary threshold shift in the subjects. The testing was preferably conducted before the start of first working day of a week or start of work day. It was ensured that the subjects were not involved in any noisy activities prior to the testing within 12 hours so that any contribution of the temporary threshold shift can be avoided and pure measure of permanent threshold shift can be computed.

Noise measurement

The noise to which the participants are exposed everyday was measured using a hand held Digital Sound Level Meter (Argonic CE 8928). The noise was measured with the microphone end of the Digital Sound Level Meter being held at the ear level of the worker. The digital SLM (Argonic CE 8928) records the noise in the environment covering a range between 40 dB to 130 dB. It has a LED display that shows the noise measured. Options are present to select fast or slow mode of measurement and an option to choose between A and C weighted scale for noise measurement. In the current study, since the noise is continuous both at airport and at railway workshop, a slow recording was chosen and 'A' weighted scale was selected for the noise measurements. Measurements were done three times at and the average of the noise level indicated were recorded. It was found that the noise to which the airport loaders were exposed to was 108.7dB (A) and railway workshop (E.M.U.) employees were exposed to 93.2 dB (A) of noise.

Statistical analysis

The data obtained on the age and the degree of the hearing loss in airport loaders and railway workshop (E.M.U.) employees with the number of years of exposure to noise were analysed by using:

- Chi- square test to test for any difference in the hearing status due to noise exposure.
- Chi- square test to test the correlation of degree and duration of noise with hearing loss.
- Chi- square test to test the impact of age on hearing loss.
- Chi- square test to test for any difference in the opinion on the hearing protective devices.

Results and Discussion

The aim of the study was profiling the hearing status of airport loaders and railway workshop (E.M.U.) employees, finding the impact of the noise on their daily life, part played by factors such as duration of noise and age contributing to the hearing loss and document their views on hearing protective devices.

The result of the study and the hypotheses put to test shall be discussed in conjunction with the objectives of the study. The implications shall be discussed in the next chapter. Each of the six objectives are studied under variables like hearing sensitivity, degree of hearing loss, duration of noise exposure in years and age of the worker. Suitable tables with their statistical value and graphs have been provided for better understanding.

The results of the questionnaire administered have been illustrated in multiple graphs for better comprehension.

Objective No.1

To study the effect of noise on the hearing in airport loaders and railway workshop (E.M.U.) employees.

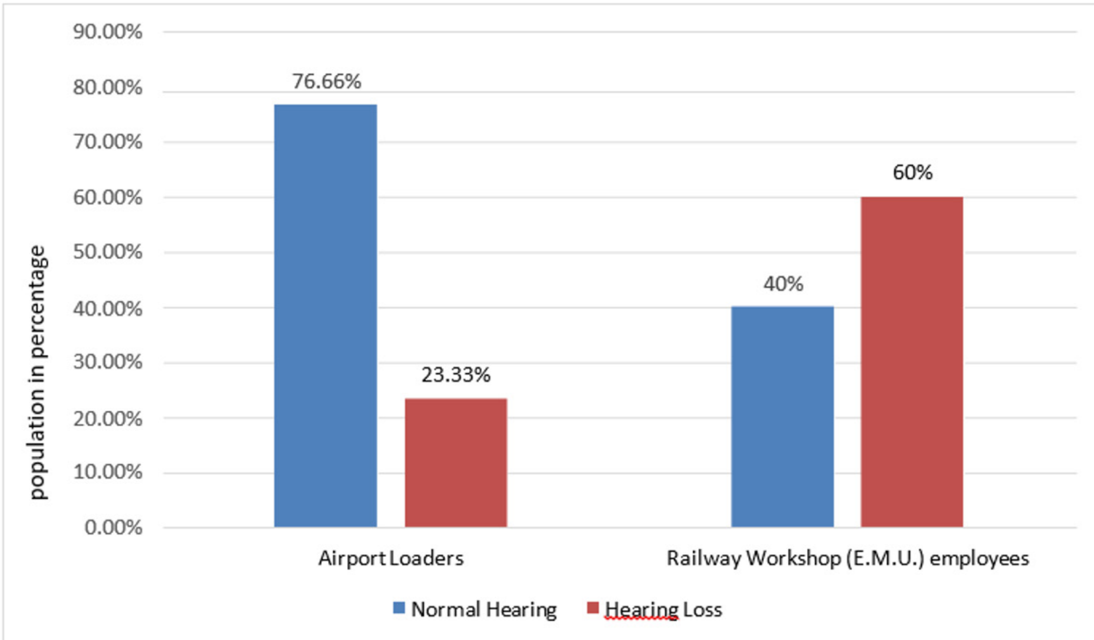

Figure 5-1.1: Represents the hearing sensitivity on X-axis and population distribution of airport loaders and railway workshop employee's on Y- axis.

With the primary objective being to study the effect of noise on the hearing in airport loaders and railway workshop (E.M.U.) employees the table 5-1.0 shows the population distribution of workers with normal hearing and hearing loss for the airport loaders and railway workshop (E.M.U.) employee's.

Table 5-1.2 reveals the results of the statistical analysis were the chi- square test was the choice depending on the data. The analysis gives chi- square value 8.3 which is significant at 0.01 level for the variables hearing sensitivity and noise exposure; leading to rejection of null hypothesis; 'higher noise levels will not create greater noise induced hearing loss' and subsequently we accept the alternate hypothesis 'higher noise levels will create greater noise induced hearing loss' i.e. noise induced hearing is significantly correlated to the noise exposure levels.

Objective No.2

To find the hearing status of airport loaders and railway workshop (E.M.U.) employees.

The table 5-2.0 (a) shows the percentage population of airport loaders with normal hearing sensitivity and mild hearing loss and the type of hearing loss and 5-2.0 (b) gives the statistical analysis performed i.e. chi- square test. The analysis reveals chi- square value of 15.08 at 0.0005 level of significance, which is highly significant.

This leads to rejection of null hypothesis i.e. 'noise level will not create a permanent threshold shift in the airport loaders' and subsequent to which the alternate hypothesis is accepted i.e. 'noise level will create a permanent threshold shift in the airport loaders.

The table 5-2.0 (c) Shows percentage population of railway workshop (E.M.U.) employees with normal hearing sensitivity, mild hearing loss, moderate hearing loss and the type of hearing loss and table 5-2.0 (d) shows the chi-square test performed and reveals the chi- square value of 5.6 which is significant at 0.05 level.

This leads to rejection of null hypothesis i.e. 'noise level will not create a permanent threshold shift in the railway workshop (E.M.U.)' and subsequent to which the alternate hypothesis is accepted i.e. noise level will create a permanent threshold shift in the railway workshop (E.M.U.) employees.

Thus noise levels create a permanent threshold shift in airport loaders and railway workshop (E.M.U.) employees.

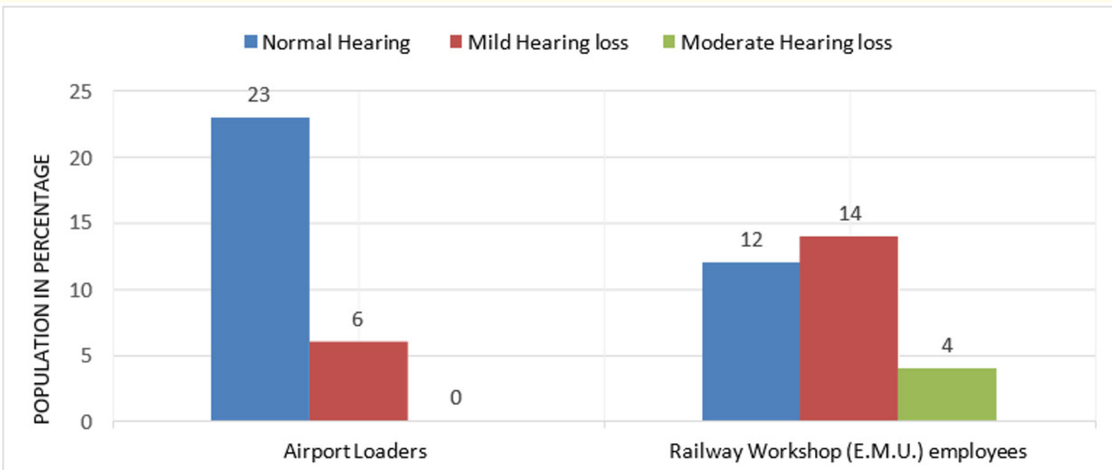

Figure 5-2.1: Illustrate the percentage population across hearing sensitivity on X-axis and the hearing loss across population in percentage for airport loaders and railway workshop (E.M.U) employees along the Y-axis.

Objective No.3

To study the factors such as age of the worker, years of exposure and duration of noise exposure on the degree of hearing loss.

Table 5-3.0 (a) gives an account of the population with normal hearing sensitivity and with degree hearing loss for the airport loaders, under two groups i.e. up to 30 years of age and above 30 years of age, for the purpose of testing the hypothesis of age being a factor in contributing to develop the noise induced hearing loss chi-square test was the statistical test of choice.

Table 5-3.0 (b) shows the result of the chi-square analysis of the above variables where the chi- square value is 15.08 which is highly significant at 0.005 level. Hence we reject the null hypothesis i.e. 'age of the worker does not have an impact on the noise induced hearing loss'. Subsequently we accept the alternative hypothesis, i.e. there is a significant correlation between the age and the noise induced hearing loss. Therefore older the airport loader greater will be noise induced hearing loss.

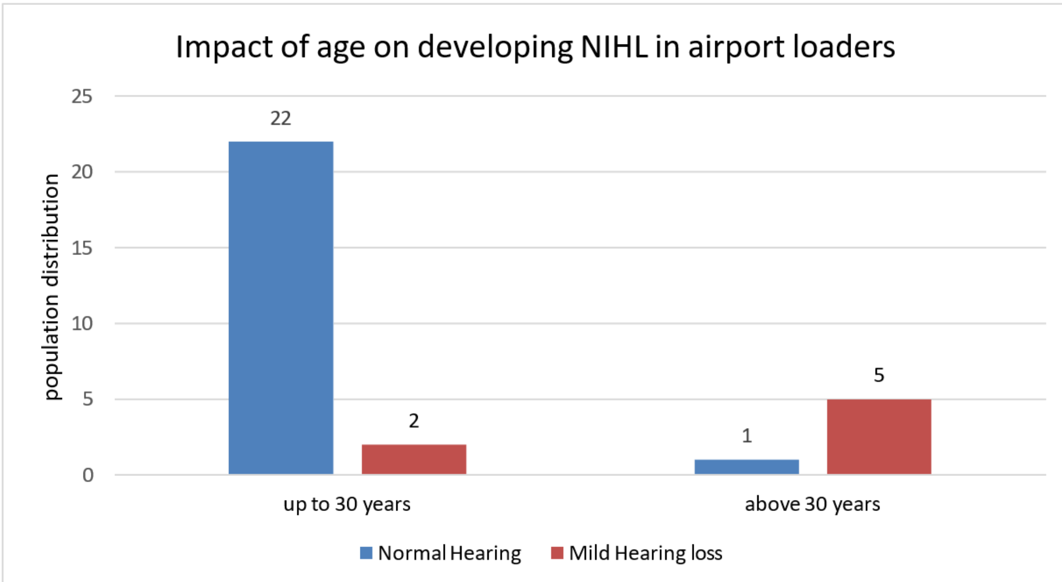

Figure 5-3.1: (a) Illustrates the population distribution of the airport loaders on Y-axis with respect to their age on X-axis.

Table 5-3.0 (c) gives an account of the population with normal hearing sensitivity and degree of hearing loss for the railway workshop (E.M.U.) employees, under two groups i.e. up to 30 years of age and above 30 years of age, for the purpose of testing the hypothesis of age being a factor in contributing to develop the noise induced hearing loss chi-square test was the statistical test of choice.

Table 5-3.0 (d) shows the result of the chi-square analysis of the above variables where the chi square value is 19.06 which is highly significant at 0.005 level. Hence we reject the null hypothesis i.e. 'age of the worker does not have an impact on the noise induced hearing loss'. Subsequently we accept the alternative hypothesis, i.e. there is a significant correlation between the age and the noise in-

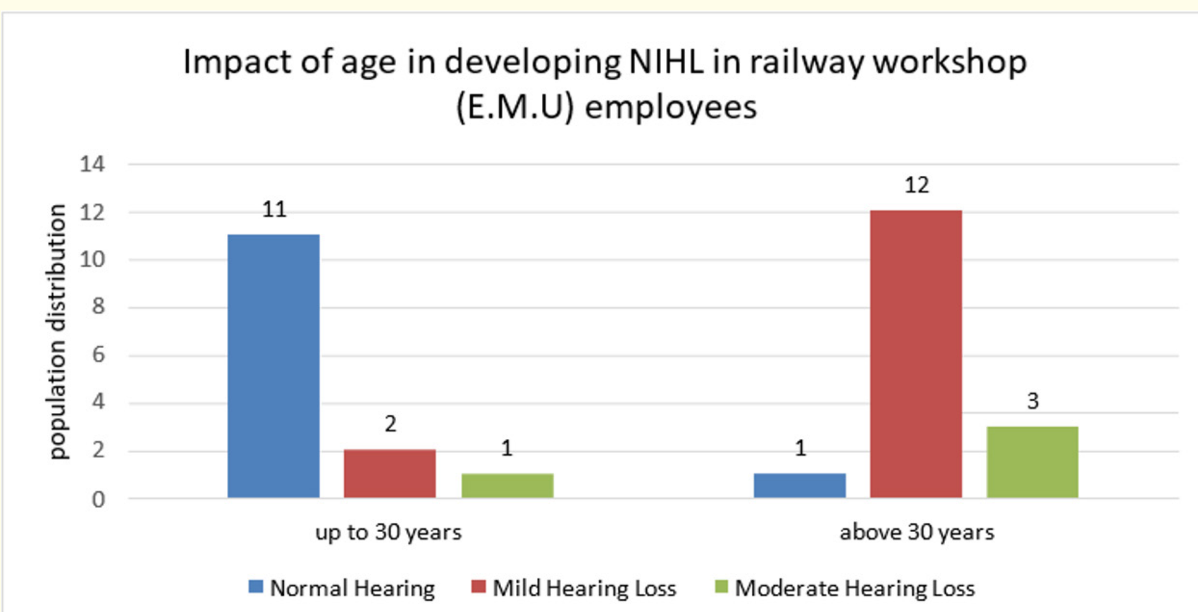

Figure 5-3.2: (b) Illustrates the population distribution of the railway workshop (E.M.U.) on Y-axis with respect to their age on X-axis.

duced hearing loss. Therefore older the railway workshop (E.M.U.) employee greater will be noise induced hearing loss.

The table 5-3.1 (a) illustrates the population been divided on the basis of degree hearing loss and normal hearing sensitivity and tested for the impact of number of years and duration of noise exposure under two groups; noise exposure up to 5 years and noise exposure above 5 years for the airport loaders. For the purpose of testing the hypothesis that longer the duration of noise exposure greater will be the noise induced hearing loss chi-square test was the statistical test of choice.

On analysis the table 5.3.1 (b), shows the result of the chi-square analysis of the above variables where the chi- square value is 15.08 which highly significant at 0.005 level. Hence we reject the null hypothesis i.e. 'that longer the duration of noise exposure greater will be the noise induced hearing loss'. Subsequently we accept the alternative hypothesis, i.e. there is a significant correlation between noise exposure and the noise induced hearing loss.

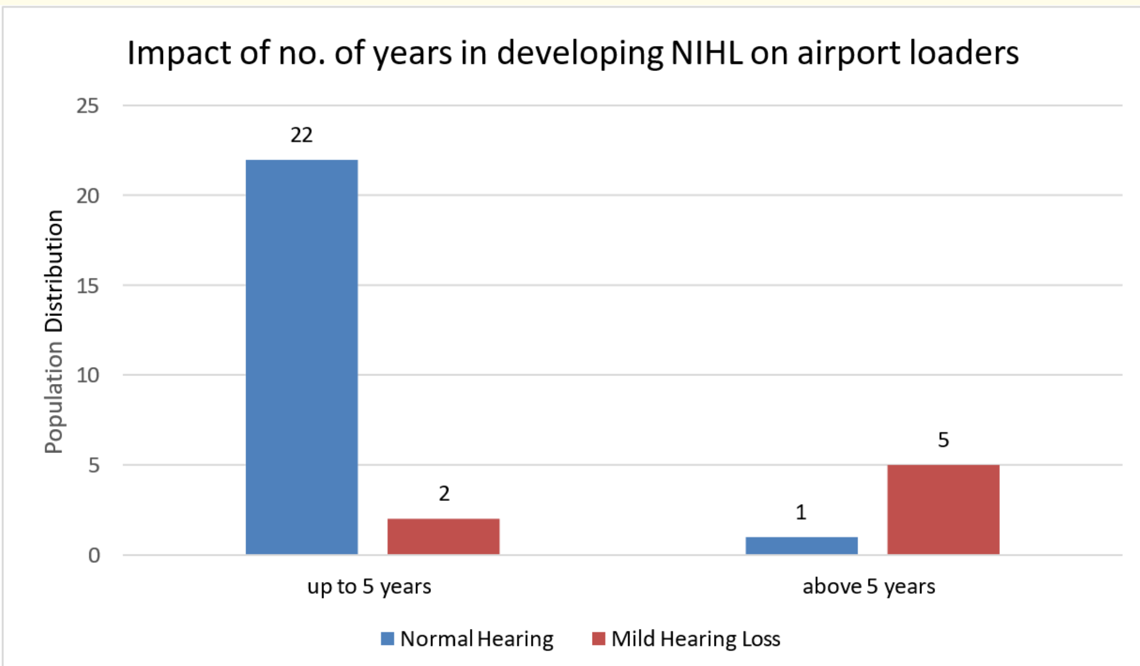

Figure 5-3.3: (a) Illustrates the impact of noise on number of years and duration on the X- axis and population distribution of the airport loaders on the Y-axis.

The table 5-3.1 (c) illustrates the population been divided on the basis of degree of hearing loss and normal hearing sensitivity and tested for the impact of number of years and duration of noise exposure under two groups; noise exposure up to 5 years and noise exposure above 5 years for the railway workshop (E.M.U) employees. For the purpose of testing the hypothesis that longer the duration of noise exposure greater will be the noise induced hearing loss chi-square test was the statistical test of choice.

On analysis, table 5.3.1 (d), shows the result of the chi-square analysis of the above variables where the value of chi- square is 12.94 which is highly significant at 0.005 level. Hence we reject the null hypothesis i.e. 'that longer the duration of noise exposure greater will be the noise induced hearing loss'. Subsequently we accept the alternative hypothesis, i.e. there is a significant correlation between noise exposure and the noise induced hearing loss.

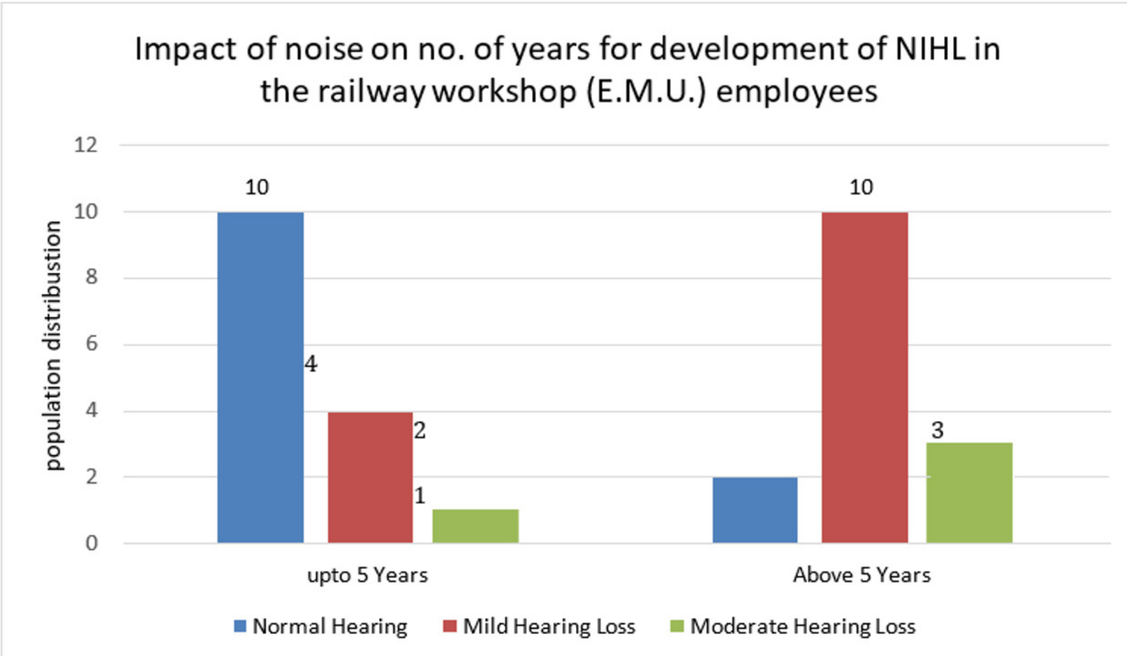

Figure 5-3.3: (b) Illustrates the impact of noise on number of years and duration on the X- axis and population distribution of the railway workshop (E.M.U.) employees on the Y-axis.

Objective No.4

To study if there is any difference in the impact of noise on the hearing sensitivity of airport loaders and railway workshop (E.M.U.) employees.

With the objective being impact of noise on airport loaders the table 5-4.0 (a) illustrates the population distribution of airport loaders with normal hearing and hearing loss along with the type of hearing loss.

Table 5-4.0 (b) shows the statistical test performed were chi-square test was the choice depending upon the data. The analysis gives the chi-square value of 8.56 which is highly significant at 0.005 level.

Table 5-4.0 (c) illustrates the population distribution of railway workshop (E.M.U.) employees with normal hearing and hearing loss along with the type of hearing loss.

Table 5-4.0 (d) shows the statistical test performed were chi-square test was the choice depending upon the data. The analysis gives the chi-square value of 0.12 which is not significant at 0.05 level. This in a way means that the people with hearing loss are more at the railway workshop (E.M.U).

Therefore the statistical analysis from the table 5-4.0 (b) and 5-4.0 (d) leads to reject the null hypothesis i.e. 'there will be no significant difference in the noise level at airport and railway workshop' (E.M.U) and subsequently accept the alternate hypothesis i.e. 'there is a significant difference in the noise level at airport and railway workshop' (E.M.U).

Objective No.5

To document the opinion about the hearing protective devices of airport loaders and railway workshop (E.M.U.) employees.

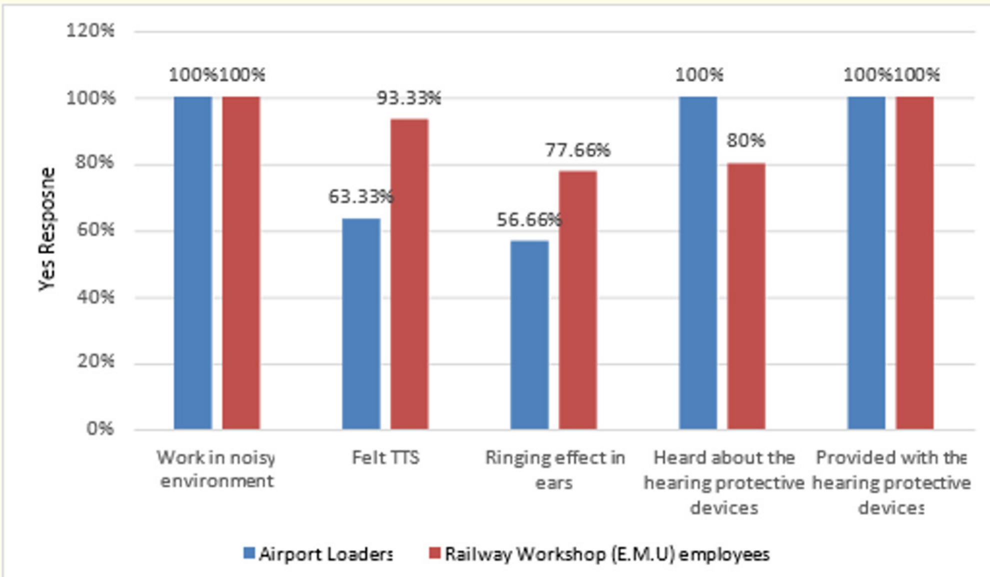

Figure 5-5.1: Shows the response of the airport loaders and railway workshop (E.M.U.) employees to questions on whether they are exposed to noise, have ever felt TTS, experienced any ringing effect, heard about hearing protective devices and whether they are provided with it shown as a function of yes response to the question.

The figure 5-5.1 shown above is the response from the airport loaders and railway workshop (E.M.U.) employees regarding the following questions:

- Whether they felt working in a noisy environment.
- Whether they have felt any temporary threshold shift (i.e. temporary reduction in the hearing sensitivity as explained to the worker) soon after they are exposed to the noise at the place of work.
- Whether they experienced any ringing effect in the ears.
- Whether they heard about hearing protective devices
- Whether they are provided with the hearing protective devices.

All the previous questions were yes/no type questions and the table contains the response of the population in percentage for the airport loaders.

Thus the above findings leads to rejection of the null hypothesis and accept the alternative hypothesis that is 'there is a significant difference in the opinion on the hearing protective devices among the airport loaders and railway workshop employees".

Objective No.6

To assess the activities and participation of airport loaders and railway workshop (E.M.U.) employees on the ICF (International

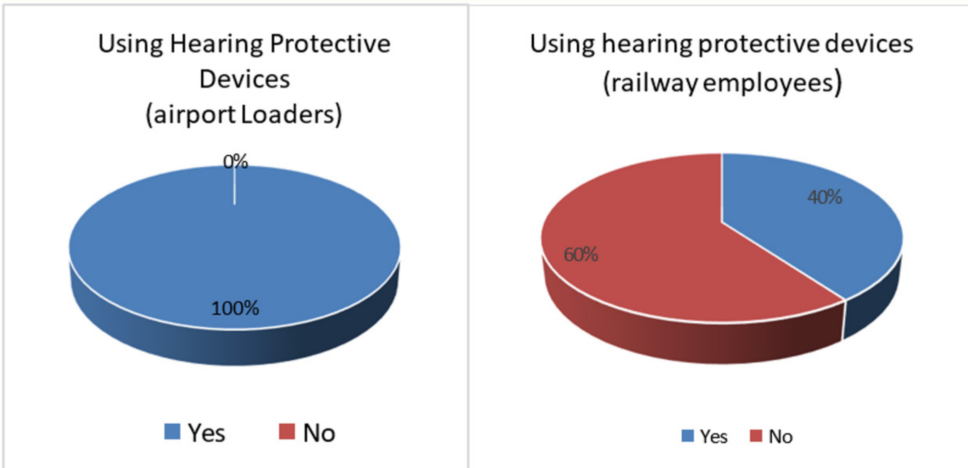

Figure 5-5.2: Illustrates the population in percentage of for airport loaders and railway workshop (E.M.U.) employees using the hearing protective devices.

Classification of Functioning, Disability and Health by WHO, 2004) frame work.

The table 5-6.0 (a) gives the following information that, about 94.73% of the airport loaders activities were not affected by noise induced hearing loss while 5.26% of the airport loaders activities were affected by noise induced hearing loss when the exposure duration was 5 years.

However, for the exposure duration of more than 5 years 45.45% of the airport loaders were not affected and 54.54% were affected by the noise induced hearing loss.

The obtained chi- square value in table 5-6.0 (b) is 8.67 which is significant at 0.01 level. Thus, the activities of the airport loaders depends on the years of noise exposure with exposure up to 5 years and above 5 years.

The table 5-6.0 (c) gives the following information that, about 94.73% of the airport loaders participation were not affected by noise induced hearing loss while 5.26% of the airport loaders participation were affected by noise induced hearing loss when the exposure duration was 5 years. However, for the exposure duration of more than 5 years 54.54% of the airport loaders were not affected and 45.45% were affected by the noise induced hearing loss.

The obtained chi- square value in the table 5-6 (d) is 8.03 which is significant at 0.01 level. This reveals that the participation of the airport loaders depends on the years of exposure to the noise and noise has an impact on the participation of airport loaders.

From table 5-6.1 (a) the following information was obtained, about 30% of the railway work shop (E.M.U.) employee's activities were not affected by noise induced hearing loss while for 70% it was affected when the duration of noise exposure was 5 years.

However when the duration of noise exposure was above 5 years 25.92% of the railway workshop (E.M.U.) employees were not affected and 74.07% were affected by the noise induced hearing loss.

The chi- square value obtained in the table 5-6.1 (b) is 8.38 which is significant at 0.05 level i.e. the noise does have impact on the activities of the railway workshop (E.M.U.) employees.

From the table 5-6.1(c), the following information was obtained, about 53.33% of the railway work shop (E.M.U.) employee's participation were not affected by noise induced hearing loss while for 46.66% it was affected when the duration of noise exposure was 5 years.

However when the duration of noise exposure was above 5 years 13.33% of the railway workshop (E.M.U.) employees were not affected and 86.66% were affected by the noise induced hearing loss.

The obtained chi- square value in the table 5-6.1 (d) is 8.28 which is highly significant at 0.005 level i.e. participation of the employees are highly affected by the duration of noise exposure.

Therefore in view of the above results, the findings may be summarized as follows:

- Higher the noise levels greater the Noise-Induced Hearing Loss (NIHL).
- Longer the duration of exposure to the noise greater was the NIHL.
- Older the worker greater was the NIHL.
- Noise levels will create a PTS in the persons working as airport loaders and railway workshop (E.M.U.) employees.
- There was significant difference in noise level at airports and railway workshop (E.M.U.).
- There was significant difference in opinion among airport loaders and railway workshop (E.M.U.) employees.

Discussion

This study profiled the hearing status of airport loaders and railway workshop (E.M.U.) employees, alongside documenting their opinions on hearing protective devices and the role played by factors such as duration of noise exposure and age in increasing susceptibility to Noise-Induced Hearing Loss (NIHL). Similar associations between occupational noise, age, and cumulative exposure have been documented in previous studies [7,22,27]. This study also examined the impact of noise on activities and participation using the International Classification of Functioning, Disability and Health (ICF) framework, consistent with established WHO guidelines [33].

From the airport and railway (E.M.U.) workshop settings, subjects were selected based on the criteria described in the methodology. Only male subjects aged 25 to 40 years were included to minimize confounding from age-related hearing loss (presbycusis), which is known to influence audiological outcomes [27]. Additionally, participants were required to have a minimum of five years of occupational noise exposure, aligning with standard epidemiological approaches to NIHL investigation [3,12,15].

The noise levels recorded at both sites were measured using a digital sound level meter (Argonic CE 8928). The recorded levels—108.7 dB(A) at the airport and 93.2 dB(A) in the railway workshop—are consistent with earlier reports indicating that aircraft engine noise and mechanical workshop noise frequently exceed safe exposure thresholds [1,2,13,19]. Although employees worked in shifts, their daily exposure often exceeded eight hours, surpassing the recommended safe limit of 90 dB for an eight-hour workday as outlined in OSHA guidelines [34].

Hearing protective devices (HPDs) were available at both work sites; however, their usage patterns differed. While HPD use was mandatory for airport loaders, it was not for railway workshop (E.M.U.) employees. Previous literature has shown similar disparities in HPD compliance, contributing significantly to variations in NIHL prevalence across occupational settings [20,31,32].

Audiological evaluation through pure-tone audiometry was performed for all subjects, followed by a field-tested questionnaire documenting their opinions on HPDs. This was further supplemented with the WHO–ICF questionnaire to assess how noise exposure influenced daily activities and participation. The functional consequences of hearing impairment, including reduced communication ability and decreased work efficiency, have been widely documented [23,24].

Each objective was examined as per the hypothesis stated. The results of hypothesis testing, along with the tables presented in the previous chapter, are discussed here with supplementary findings and appropriate justification based on existing literature [4,21].

Objectives

Objective 1: To study the effect of noise on the hearing in airport loaders and railway workshop (E.M.U.) employees.

Table 5-1.0 lists the population distribution of the airport loaders and railway workshop (E.M.U.) employees with normal hearing sensitivity and hearing loss.

The study reveals that although a significant proportion of airport loaders and railway workshop (E.M.U.) employees have normal hearing sensitivity, a much larger proportion of railway workshop employees show hearing loss. This is consistent with prior literature reporting that workshop and mechanical industry workers experience higher NIHL prevalence due to continuous exposure to machinery noise and poor use of hearing protection [13,19,29].

Thus, 76.66% of the airport loaders demonstrated normal hearing sensitivity, whereas only 40% of the railway workshop employees showed normal hearing. Further, 23.33% of airport loaders had hearing loss compared to 60% of railway workshop employees.

This finding was strengthened by statistical analysis, which demonstrated a significant correlation between noise exposure and hearing loss (see Table 5-1.0 and 5-1.2), thereby rejecting the null hypothesis and aligning with earlier studies documenting strong dose–response relationships between noise levels and threshold shifts [4,22].

This clearly indicates that railway workshop employees exhibit a higher rate of hearing loss compared to airport loaders. A major contributing factor is that airport loaders are mandated to use hearing protective devices (HPDs), whereas no such mandate exists in the railway workshop, resulting in poor compliance (see Objective 5 results, p. 45). Previous studies have highlighted similar patterns of inadequate HPD use leading to higher NIHL prevalence among workshop and transportation workers [20,31,32].

Similar findings were reported by Pankova (2008), who documented occupational hearing loss among railway workers and emphasized the importance of consistent HPD use as a preventive measure [29].

Objective 2: To find the hearing status of airport loaders and railway workshop (E.M.U.) employees.

Table 5-2.0(a) lists the distribution of airport loaders categorized as normal hearing or mild hearing loss, while Table 5-2.0(c) lists railway workshop employees categorized as normal hearing, mild hearing loss, and moderate hearing loss, including type of hearing loss.

This study reveals that a significant proportion of participants suffer from sensorineural hearing impairment of mild to moderate degree:

- 23.33% of airport loaders and
- 46.66% of railway workshop employees show mild hearing loss, while 13.33% of railway workshop employees demonstrate moderate hearing loss. Meanwhile, 76.66% of airport loaders and 40% of railway workshop employees retain normal hearing sensitivity.

These findings align with previously documented prevalence patterns of NIHL among aviation and industrial workers, where sensorineural losses—particularly at higher frequencies—are most common [3,12,15,26].

This has been supported by statistical analysis, wherein a highly significant correlation was found between noise exposure and permanent threshold shifts (see Tables 5-2.0(b) and 5-2.0(d)), thus accepting the alternate hypothesis that occupational noise leads to irreversible changes in hearing thresholds—an outcome consistent with global NIHL research [4,21,23].

Similar findings were reported by Imtiyaz and Riyaz (2008), who observed significant differences in NIHL prevalence between noise-exposed and non-exposed airport workers [16].

Kryter (1991) also reported that railway noise produces notable hearing losses, especially at high frequencies, reinforcing the present study's findings among railway workshop employees [19].

Objective 3: To study factors such as age, years of service, and duration of noise exposure on the degree of hearing loss.

This objective was achieved using pure tone audiometry (PTA2 was considered). Analysis of age categories showed a significant increase in hearing impairment with increasing age, aligning with established findings that age-related susceptibility amplifies chronic occupational noise effects [13,18,27,31].

Similar findings were reported by Mohd. Nasir Habib (2008), who noted that hearing loss prevalence was four times higher in workers above 40 years of age and three times higher when noise exposure exceeded five years [31]. Clark (1989) also observed significant age-related hearing differences among railroad workers but no major differences based solely on years of service.

Analysis of duration of noise exposure revealed that hearing loss increased substantially with longer exposure. Statistical analysis confirmed a significant correlation between exposure duration and hearing loss, supporting occupational findings showing cumulative noise exposure is directly related to NIHL severity [4,13,22]. Nasir (2012) similarly documented strong associations between long exposure durations and NIHL in Malaysian airport workers [12].

These findings indicate that duration of noise exposure plays a major role in causing hearing loss, with greater exposure duration leading to reduced hearing sensitivity. This aligns with NIHL progression models demonstrating that prolonged exposure accelerates cochlear damage and increases permanent threshold shift [4,13,22].

Objective 4: To study if there is any difference in the impact of noise on the hearing sensitivity of airport loaders and railway workshop (E.M.U.) employees.

Chi-square analysis revealed a significant difference in the number of individuals with hearing loss at the airport, whereas no such difference was found among railway workshop employees. This aligns with evidence linking hearing outcomes to differences in HPD compliance and exposure patterns across industrial worker groups [7,12,20,28].

The lack of mandatory HPD usage among railway workshop employees emerged as a major contributor to their higher rates of hearing loss. Workers reported barriers such as interference with speech communication (60.30%), bulky design, ear discomfort, and forgetfulness—factors consistent with prior studies showing that comfort and communication issues reduce HPD compliance [28,33]. With continuous noise levels around 93.2 dB(A), exceeding recommended limits [19,21,23], 60% of these workers developed hearing loss, whereas only 23.33% of airport loaders were affected due to mandatory HPD usage.

Other contributing factors include continuous exposure without relaxation periods and lower awareness of noise hazards. Continuous exposure is known to increase NIHL risk by limiting cochlear recovery between noise events [13,18,19]. In contrast, airport loaders have intervals of reduced exposure between flights, allowing partial auditory recovery. Higher education and awareness among airport loaders may also explain their better hearing status, consistent with studies linking awareness with improved HPD compliance [20,28].

These findings strongly recommend mandatory HPD use and increased awareness among railway workshop employees. Renne and Bessette (2008) emphasized HPD provision for railway workers exposed to noise levels exceeding OSHA limits [32]. Pankova (2008) similarly documented occupational hearing loss among railway workers and advocated mandatory HPD usage as a preventive measure [29].

Objective 5: To document the opinions about hearing protective devices among the airport loaders and railway workshop (E.M.U.) employees.

A field-tested questionnaire was used to obtain these responses. Both groups acknowledged working in a noisy environment, with 63.33% of airport loaders and 93.33% of railway workshop employees reporting temporary threshold shift following their work hours—an effect widely recognized as an early marker of NIHL risk [4,20,22].

Additionally, 56.66% of airport loaders and 77.66% of railway workshop employees reported tinnitus, a common early symptom of noise-induced cochlear stress documented in occupational studies [22,24]. Awareness of hearing protective devices was 100% among airport loaders and 80% among railway workshop employees, though access does not guarantee consistent usage—a pattern noted frequently in industrial hearing conservation research [28,33].

Reasons for non-use of HPDs among railway workshop employees included interference with speech communication (60.30%), bulky design (21.40%), discomfort or ear pain (15.60%), and forgetfulness (2.70%). These barriers match previously published findings identifying communication difficulty, discomfort, and inconvenience as major contributors to HPD non-compliance [28,33]. Even airport loaders, though mandated to use HPDs, informally reported similar complaints.

Evidence from prior hearing conservation programs supports the need for user-friendly, ergonomically improved HPDs. Gosztonyi RE Jr. (1975) demonstrated that hearing conservation programs incorporating audiometric testing and personal ear protection at ~90 dB(A) effectively protected workers [33]. Mathew and Martins (2012) similarly found that interventions aimed at improving HPD compliance significantly enhanced protective usage in high-noise settings [20].

Objective 6: To assess the activities and participation of airport loaders and railway workshop (E.M.U.) employees using the ICF (International Classification of Functioning, Disability and Health) framework.

The data showed that functional limitations and participation restrictions increased substantially with longer durations of noise exposure. These findings correspond to prior studies indicating that NIHL affects communication efficiency, daily functioning, and social participation [22,26].

Activities and participation outcomes showed a significant shift depending on duration of noise exposure. Among airport loaders, affected activities increased from 5.26% (≤5 years) to 54.54% (>5 years). Among railway workshop employees, affected activities increased from 70% to 74.07%. Participation restrictions rose from 5.26% to 45.45% among airport loaders and from 46.66% to 86.66% among railway workshop employees. These findings align with ICF-based occupational studies documenting NIHL-related limi...

A review of literature indicates that few studies have evaluated activities and participation components of NIHL among airport loaders and railway workshop employees, making this investigation a valuable contribution. The results support the broader understanding that duration of exposure and age play major roles in determining NIHL severity, consistent with audiological and occupational health research [13,18,22,27,31].

Furthermore, findings reveal that consistent use of hearing protective devices can reduce—though not fully eliminate—the risk of NIHL. This conclusion is also strongly supported by previous HPD-compliance and NIHL-prevention research [20,28,33].

Given the risks faced by airport loaders and railway workshop (E.M.U.) employees, there is an immediate need to create widespread awareness regarding the health hazards associated with excessive occupational noise. Although many workers acknowledge having hearing difficulties, they often do not consider these health issues significant compared to the need to secure their livelihood. Similar observations have been documented in occupational health research, where workers tend to underestimate NIHL severity despite recognizing its presence [22,26,34].

There are provisions in Indian legislation for monitoring and controlling noise through environmental and labor safety regulations. However, WHO (1999) reported that India remains one of the countries where noise surveys and related studies are among the least initiated, contributing to under-diagnosis and poor prevention of NIHL [23,26,34].

In a country like India—characterized by limited job opportunities, high unemployment, and widespread poverty—workers may hesitate to report noise-related health problems for fear of losing their livelihoods. This socioeconomic barrier has been recognized in prior occupational health studies, where workers prioritize job security over health protection [22,34]. In keeping with public health principles, it is emphasized that "health is the ultimate wealth," underscoring the importance of preventive occupational health measures [26,34].

Conclusion

The present study aimed to profile the hearing status of airport loaders and railway workshop (E.M.U.) employees, examine the impact of duration of noise exposure and age on the development of noise-induced hearing loss (NIHL), document opinions regarding hearing protective devices, and assess activity limitations and participation restrictions using the ICF framework (WHO, 2004). These objectives align with established occupational audiology approaches integrating audiometric evaluation with functional and behavioral assessments [20,22,26].

The study recorded noise levels of 108.7 dB(A) at the airport and 93.2 dB(A) at the railway workshop—both exceeding international safety limits and consistent with noise ranges documented in prior aviation and railway noise studies [1,5,13,19,21,23]. Participants were aged 25–40 years with a minimum of 5 years of noise exposure, durations considered sufficient in earlier research to induce permanent threshold shifts [4,13,22].

Audiological results showed that 23.33% of airport loaders and 46.66% of railway workshop employees exhibited mild hearing loss, while 13.33% of railway workshop employees demonstrated moderate hearing loss. These findings support prior reports of elevated NIHL prevalence in transportation-sector workers exposed to continuous or intermittent high-intensity noise [1,3,12,13,19]. A strong correlation was observed between duration of exposure, age, and degree of NIHL, consistent with established literature on cumulative exposure and aging contributing to auditory decline [13,18,22,27,31].

Only 40% of railway workers reported using hearing protective devices (HPDs) compared to 100% of airport loaders, emphasizing the critical role of HPD compliance in NIHL prevention—findings that mirror earlier occupational studies [20,28,33].

ICF-based assessment revealed that both activities and participation were affected, particularly when exposure exceeded 5 years, aligning with prior research that NIHL impacts communication, daily functioning, and social roles beyond auditory thresholds [22,24,26].

In conclusion, the study highlights significant occupational noise hazards in airport and railway workshop environments and underscores the need for effective hearing conservation programs, strict HPD compliance, and policy-driven noise control interventions to mitigate NIHL risk [20,23,24,34].

Salient Features of the Study

There is a strong correlation between the duration of noise exposure and noise-induced hearing loss (NIHL). Longer exposure increases the severity of permanent threshold shift, consistent with established NIHL research findings [4,13,18,22].

There is also a strong correlation between age and NIHL. Age-related susceptibility increases the vulnerability of workers to cochlear damage, a relationship supported by several documented studies in auditory aging and occupational audiology [13,18,27,31].

Hearing protective devices (HPDs) can significantly reduce the hazardous effects of noise. Mandatory use and improved compliance have been shown to reduce NIHL prevalence in high-noise work environments [20,28,33].

The use of clinical audiometers in sound-treated rooms following ASHA/ANSI guidelines, along with strict exclusion criteria, ensured accurate and reliable measurement of permanent threshold shifts. This methodology aligns with best practices in occupational audiological assessment [20,22,24].

This data will support the implementation of hearing conservation programs in India, consistent with global recommendations aimed at reducing occupational NIHL [20,23,33,34].

Limitations of the Study

The current study was conducted on a sample of 60 subjects (30 in each group), which is relatively small considering the total workforce at airports and railway workshops. Small sample sizes are known to limit the generalizability of NIHL findings in occupational research [22,26,34].

Only male subjects were included in the study. Previous NIHL investigations highlight that gender imbalance limits understanding because susceptibility and exposure patterns may differ between males and females [26,34].

Only two exposure-duration categories were considered—up to 5 years and above 5 years. Studies evaluating NIHL progression emphasize that more detailed exposure-time stratification improves risk interpretation and accuracy [18,22,27].

The study did not assess psychosocial effects of noise, such as stress, sleep disturbance, cardiovascular strain, or cognitive burden. Prior research has established that noise has substantial non-auditory health effects that contribute to overall worker well-being and functioning [22,24,26].

Further Research

Considering the noise levels documented in this study, future research should evaluate railway engine drivers and fighter jet pilots, as both groups are exposed to extremely high-intensity noise. Prior occupational studies identify these professions as having elevated NIHL risk [1,5,13,19].

Studies should be conducted to increase awareness of health issues associated with intense noise exposure and to educate workers about hearing protection and relevant legislative provisions. Public health reports highlight lack of awareness as a major barrier to NIHL prevention in developing countries [23,26,34].

Technical and engineering interventions should be undertaken to reduce noise levels at airports and railway workshops, including the use of quieter machinery, improved administrative controls, and advanced noise-reduction designs. These strategies are widely recommended in NIHL prevention literature [19,21,23].

Baseline (pre-employment) audiological evaluations should be made mandatory, with periodic follow-up assessments to detect early NIHL. This aligns with global best practices for hearing conservation programs [20,22,33].

Future studies should include female workers to examine potential gender differences in NIHL susceptibility, as some occupational health research suggests demographic variations in risk patterns [26,34].

Summary

Noise is often referred to as a 'silent killer,' with serious consequences for individuals exposed to it regularly. From an audiological perspective, noise produces both auditory and non-auditory effects. Auditory effects include temporary threshold shift (TTS) and permanent threshold shift (PTS), both firmly established in occupational NIHL literature [4,13,18,22]. Non-auditory effects include sleep disturbance, cardiovascular stress, mental health strain, and impaired task performance, consistent wi...

Although India has legislation intended to monitor and regulate noise, WHO (1999) reports indicate that India remains one of the countries with the least number of noise surveys and related studies. This has contributed to poor awareness, weak enforcement, and under-diagnosis of NIHL in occupational sectors [23,26,34].

This study aimed to document audiological findings and workers' opinions on the efficacy of hearing protective devices, evaluate the impact of noise-exposure duration and age on NIHL, and assess activity limitations and participation restrictions using the ICF framework (WHO, 2004). Noise levels measured were 108.7 dB(A) at the airport and 93.2 dB(A) at the railway workshop—values consistent with hazardous levels documented in earlier aviation and railway studies [1,5,13,19,21,23].

Chi-square analysis revealed significant correlations between noise-exposure duration and degree of NIHL, as well as between age and NIHL, findings that align with previous research showing that cumulative exposure and aging jointly contribute to auditory decline [13,18,22,27,31].

There was a significant difference in HPD usage between groups: only 40% of railway workers used HPDs, while all airport loaders reported usage due to institutional mandates. This matches earlier literature showing that HPD compliance is a major determinant of NIHL prevention [20,28,33].

Assessment using the ICF framework showed that both activity performance and participation were affected in workers from both groups, particularly when exposure exceeded 5 years. These outcomes reflect NIHL's broader functional and social impact beyond audiometric thresholds [22,24,26].

The results of this study can be summarized as follows:

- Higher noise levels resulted in greater NIHL, consistent with exposure-response trends in occupational noise studies [1,5,13,19].
- Longer duration of exposure produced greater NIHL, reflecting cumulative dose-effect relationships [4,13,22,27].
- Older workers were at greater risk of NIHL due to age-related susceptibility [13,18,27,31].
- Noise exposure caused measurable permanent threshold shifts among airport loaders and railway workshop employees [22,24,26].
- There was a significant difference in environmental noise levels between airports and railway workshops [19,21,23].
- There was a significant difference in HPD usage between the two worker groups, affecting NIHL prevalence [20,28,33].

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NILL.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this research.

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