Section: Miscellaneous

Original Research Article

OCCUPATIONAL NOISE INDUCED HEARING LOSS (ONIHL) AMONG AUTOMOBILE INDUSTRIAL WORKERS: PREVALENCE, PREDICTORS AND PREVENTION STRATEGIES

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ABSTRACT

Background: Occupational noise-induced hearing loss (ONIHL) is a significant concern in the automobile industry, where workers are exposed to high noise levels. Aim: This study aims to determine the prevalence of occupational NIHL among workers in the automobile industry, identify predictors of NIHL, and evaluate the effectiveness of prevention strategies in reducing NIHL. The study will use a cross-sectional design to achieve its objectives.

Materials and Methods: Across-sectional study was conducted among 184 workers in the automobile industry to assess the prevalence, its associated risk factors and effectiveness of PPEs.

Results: The study revealed that 8.7% of participants had ONIHL, despite widespread use of hearing protection equipment.

Conclusion: Audiometric evaluation showed that while most workers had normal hearing, a significant portion had slight to moderate hearing impairment, particularly those in elder age groups. The study highlights the need for continuous monitoring, preventive strategies and inclusive health interventions to protect the hearing health of workers in the automobile industry, especially those with underlying medical conditions. The findings emphasize the importance of addressing ONIHL as a critical occupational health concern.

Keywords: Occupational Noise Induced Hearing Loss, Standard Threshold Shift, Sound Intensity-Measured in decibels (dB), Personal Protective equipment's, Industrial Noise.

INTRODUCTION

Occupational noise-induced hearing loss (NIHL) is a significant health hazard affecting workers in various industries worldwide, including the automobile industry. Prolonged exposureto loud noises in the work place can lead to permanent hearing damage, tinnitus, and other related health issues. The automobile industry is a significant contributor to the global economy, but it also poses significant occupational health risks to its workers. Noise pollution is a major hazard in this industry, with workers exposed to high noise levels from machinery, engines, and tools. According to the World Health Organization (WHO), approximately 360 million people worldwide suffer from hearing loss, with occupational noise exposure being a significant contributor.[11] In the United States, the National Institute for the Occupational Safety and Health (NIOSH) estimates that 22 million workers are exposed to hazardous noise levels in the workplace, with the automobile industry being one of the top five industries for noise exposure.[7] Studies have consistently shown a high prevalence of NIHL among workers in the automobile industry. A study in Malaysia found that30% of automotive repair workers had NIHL.[1] Similarly, a study in India

found that 35% of automobile workers had NIHL.[8] Another study in Brazil found that 28% of workers in the automotive industry had NIHL.[5] The predictors of NIHL among workers in the automobile industry include duration and intensity of noise exposure, age, and individual susceptibility.[5-9] Effective prevention strategies include the use of personal protective equipment (PPE), engineering controls, and administrative controls (NIOSH, 2020). This study aims to determine the prevalence of occupational NIHL among workers in the automobile industry, identify predictors of NIHL, and evaluate the effectiveness of prevention strategies in reducing NIHL. The study will use a cross-sectional design to achieve its objectives.

Short-term exposure to excessive (too much) noise can cause temporary hearing loss, lasting from a few seconds to a few days. Exposure to noise over a long period of time can cause permanent hearing loss. Hearing loss that occurs over time is not always easy to recognize and unfortunately, most workers do not realize they are going deaf until their hearing is permanently damaged.

Temporary threshold shift: The ringing and the feeling of deafness normally wear off after you have been away from the noise for a short time. After leaving work, it may take several hours for a worker's ears to recover. This may cause social problems because theworkermayfind it difficult tohearwhat other people are saying or may want the radio or television on louder than the rest of the family.

Permanent hearingloss can never be repaired. This type of damage to the ear can be caused by long- term exposure to loud noise or, in some cases, by short exposures to very loud noises.

Exposureto noise inthe workplace can cause a variety of other problems, including chronic health problems:

Exposure to noise over a long period of time decreases coordination and concentration. This increases the chance of accidents happening. Noise increases stress, which can lead to a number of health problems, including heart, stomach and nervous disorders. Noise is suspected of being one of the causes ofheartdiseaseand stomach ulcers. Workers exposed to noise may complain of nervousness, sleeping problems and fatigue (feeling tired all the time).

Excessive exposure to noise can also reduce job performance and may cause high rates of absenteeism. An effective way to measure the noise in your workplace is with a sound meter.

The study highlights the need for continuous monitoring, preventive strategies and inclusive health interventions to protect the hearing health of workers in the automobile industry, especially those with underlying medical conditions. The findings emphasize the importance of addressing ONIHLas a critical occupational health concern.

Noise is measured interms of intensity, frequency, wave length, speed, pressure and depends on sound fields. Human ear hears the sound frequencies between 20 Hz to 20,000 Hz. Human speech frequencies are in the range of 250 Hz to 3000 Hz.

Noise may be classified as:

- Continuous noise
- Intermittentnoise
- Impulsenoise

Sources of Noise

Apart from the noise at work place, it is a hazard out of work are alike traffic noise, overcrowded areas, loud speakers, house hold noise, cultural stage shows. Usage of mobiles, head phones and ear phones constantly can also be a hazard. They are heterogeneous typically perceived as intermittent, fluctuating and irregular enough. The variability is large.

In Industries the sources of sound maybe

- Machinery like Pneumatic drills
- Noisy tasks like Construction Works, Demolition Works, Forging, Stamping, and Fabrication etc.
- Impact noise like Hammering, drop forging, Pneumatic impact tools, Cutting machines etc.
- Physiologically auditory effects of the sound stimulation and hazardous noise have the following responses by human ear.
- Adaptation/per stimulatoryfatigue
- Noise induced temporary threshold shift(NITTS)/ post stimulatory fatigue
- Noise induced permanent threshold shift (NIPTS)/noise induced hearing loss(NIHL) Noise induced hearing loss (NIHL) most commonly occurs at 4kHz. Therefore, thereis a notch at 4kHz.

Figure 1: Audiogram

Table 1: Permissible Exposure Levels of Impulsive or Impact Noise

Peak Sound Pressure Levels in dB	Permitted No. of Impulse/Impact Per Day
140	100
135	315
130	1000
125	3160
120	10000

Table 2: Permissible Exposure in cases of Continuous Noise

Total Time of Exposure (Continuous Short Term Exposure)	Sound Pressure Level in or a number of dBA per day (In Hours)
8	85
6	87
4	90
3	92
2	95
1½	97
1	100
3/4	102
1/2	105
1/4	110

Standard and Statutes

The Factories Act 1948–Lists Noise induced Hearing Loss as a notifiable disease in Schedule III, under Sec 89; Power to direct enquiry into cases of accident or disease under Sec 90.

DGFASLI model rules–Under Schedule XXIV noise induced hearing loss is notifiable, Model Factories Rules 120 under Section 87.

As per OSHA standards:

Noiseexposureof8hoursTWAshouldbe lessthan85dBA. **As per Model Factories Rules, 2020, Rule -120 under Section 87:** Noise exposure should be less
85dBA.

International Labor Organization:

Occupational Safety & Health Convention155, Recommendation 164,1981: Safe Noise Levels.

ILO Convention155, Recommendation164, 1981: Occupational Safety and Health Convention (3j)

ILO Convention148, Recommendation 156, 1977: Working Environment (Air Pollution, Noise, Vibration)

MATERIALS AND METHODS

Workers working in automobile industry were selected on the basis of inclusion and exclusion criteria. Inclusion criteria include workers between 18-60 yrs. of age exposed to high noise levels above 85dB with atleast 6 months of work experience and willing to participate in study.

All participants were introduced to the purpose of and procedures to be followed in this study
and questionnaire was filled by participants. Cross sectional study on184 workers in the automobile industry exposed to high noise levels was selected.

Cross sectional study on184 workers in the automobile industry exposed to high noise levels

A general walk through survey is done to access the noise levels, sources and types of noise, employees exposed to noise.

Generally the noise is heard in combination of the sounds produced from different sources. The intensity of the combined noise is calculated by the following method. Correction Factoris added to the higher threshold level sound, when two sound sources are nearby.

Table 3: Difference between sources (dB)

S.No	Difference between sources (dB)	Correction factor
1	0-1	3
2	2-3	2
3	4-9	1
4	>10	0

To identify the noise prone areas, noise mapping is done.

Noise Mapping is a strategic noise map is a graphical representation of the predictedsituationwithregardstonoiseinaparticularare aandfromparticular noise sources, with different colors representing different noise levels in decibels [dB(A)]

Noise levels measurements are done at these noise prone areas using Sound Level meter and marked different sources of noise. Combined noise is taken in to consideration here. This includes the noise generated from different sources at the work area where employees are working in day to day shifts.

Figure 2: Equipment for Noise Measurement

Audiometry is done to the employees working in these noises prone areas and compared with the previous readings. Anydeviation or shifts in hearing threshold levels are observed.

Health records from Periodic Medical Examination are seen to evaluate Auditory & Non Auditory Effects on the employees.

Statistical analysis:

Data analysis techniques used

The data analysis was performed using statistical software IBM SPSS Statistics 26.0

he sample of 184 employees from these noise prone areas are assessed through

Noise level monitoring:

- Sound level meter measurements

Evaluation of Health effects

- Questionnaire
- Medical Records
- Audiometry readings

Noise Monitoring: Noise levels are studied in virtue ofthe exposed person to noise from multiple sources. The combined noise is taken in to consideration.

Table 4: Average Noise Levels

Area	Noise intensity
E3-E4,Press Shop	94 dB
E11-E12,Press Shop	92 dB
CPED,GeneratorRoom	96 dB
C7-C8,Engine Testing	90 dB
Chassis/ Xenon	96 dB
RBT,LoadBody	95 dB

RESULTS

The age-wise distribution shows that the majority of participants (59.2%) were aged 50-59 years, followedby22.8%inthe40-49 years age group. The smallest groups were those aged 30-39 years (13.6%) and 20-29 years (4.3%).

The descriptive statistics for age show that the mean age is 48.14 years and a median of 51.00 years. The standard deviation is 8.86 years and the age range spans 39 years, from aminimum of 20.00 years to a maximum of 59.00 years.

Table 5: Age-wise distribution

Age	Frequency	Percent
20-29	8	4.3%
30-39	25	13.6%
40-49	42	22.8%
50-59	109	59.2%
Total	184	100.0%

Table 6: Descriptive Statistics forage

n	Mean	Median	SD	Range	Min	Max
184	48.14	51.00	8.86	39.00	20.00	59.00

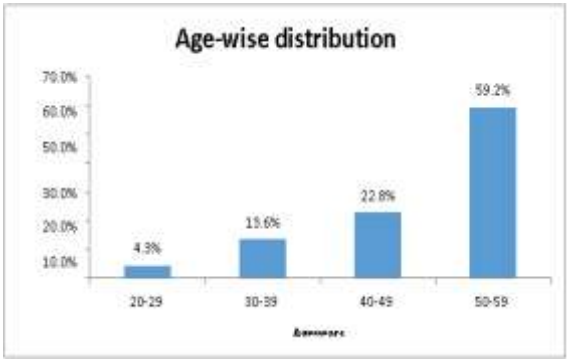

Figure 3:

The department-wise distribution shows that the largest group of participants (31.5%) work in the E 3/4 press shop, followed by 23.4% in the D9 Engine department and 22.8% in the CPED department. The E 11/12 press shop accounts for 15.8% of participants, while the Xenon J 13 and RBT Load Bodydepartments have the smallest representations, with 3.8% and 2.7%, respectively. [Figure 3]

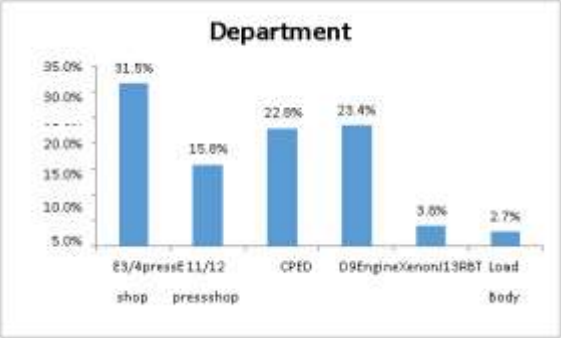

Figure 4:

The experience distribution shows that 41.3% of participants have20-30 years of experience, followed by 27.7% with10-20 years of experience and 23.9% with30-40 years. The smallest group, 7.1%, has 0-10 years of experience.

The descriptive statistics for years of experience among participants show the mean experience of 23.67 years and a median of 28.91 years. The standard deviation is 9.27 years, and the range of experience spans 35.40 years, with a minimum of 1.00 year and a maximum of 36.40 years. [Figure 4]

The comparison of noise levels before and after the use of Hearing Protection Equipment (HPE) shows a significant reduction. Themean noise level decreased from 93.306 dBbefore HPE use to 64.306 dB after HPE use. Both measurements have the same standard deviation (SD) of 2.244 and standard error of the mean (SEM) of 0.166. The p-value is less than .001, indicating a statistically significant difference in noise levels before and after the use of HPE. [Figure 5]

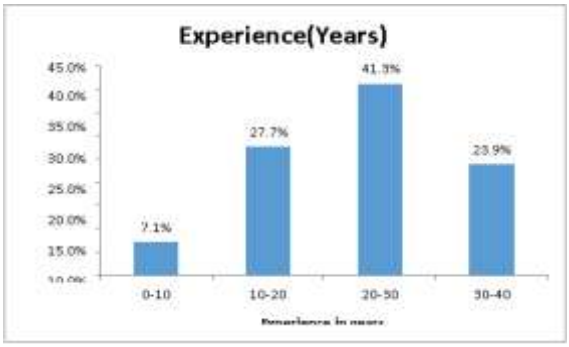

Figure 5:

Table 7: Department

Department	Frequency	Percent
E3/4press shop	58	31.5%
E11/12press shop	29	15.8%
CPED	42	22.8%
D9 Engine	43	23.4%
XenonJ13	7	3.8%
RBT Load Body	5	2.7%
Total	**184**	**100.0%**

Table 8: Experience (Years)

Experience (Years)	Frequency	Percent
0-10	13	7.1%
10-20	51	27.7%
20-30	76	41.3%
30-40	44	23.9%
Total	184	100.0%

Table 9: Comparison of Noise level (dB) before and after use of HPE

	Mean	N	SD	SEM	p-value
Noise Before	93.306	184	2.244	0.166	<.001**
Noise After	64.306	184	2.244	0.166	

Table 10: Source of Noise

Source of Noise	Frequency	Percentage
Mechanical press	87	47.3%
Diesel Generator	42	22.8%
Enginetestbed	43	23.4%
Chassis punching machine/Nut runner machine	7	3.8%
RBTmachine- Roller	5	2.7%
Total	184	100.0%

The data shows that all participants (100.0%) use Hearing Protection Devices (HPD) at work, specifically year plugs or ear muffs. They consistently use HPD throughout all working hours, excluding breakfast and lunch times. Additionally, all participants (100.0%) have undergone audiometry in the last 12 months. The results of these audiometry tests indicate that 91.3% have normal hearing, while 8.7% have experienced hearing deterioration. The prevalence of occupational NIHL among workers was approximately 8.7%.

Table 11: Do you use HPD at work

Do you use HPD at work	Frequency	Percentage
Yes	184	100.0%

Table 12: Type of HPD

Type of HPD	Frequency	Percentage
Earplugs/Earmuffs	184	100.0%

Table 13: Frequency of use of HPD

Frequency of use of HPD	Frequency	Percentage
All working hours,excluding breakfast and lunch time	184	100.0%

Table 14: Audiometry done in last 12 months

Audiometry done in last 12 months	Frequency	Percentage
1.00	184	100.0%

Table 15: Result of audiometry

Result of audiometry	Frequency	Percentage
Normal	168	91.3%
Impaired	16	8.7%
Total	184	100.0%

The WHO grading of hearing impairment shows that for the left ear, 70.7% of participants have no impairment, 28.3% have slight impairment, and 1.1% have moderate impairment. Fortherightear,83.7% have no impairment,15.2% haves light impairment, and1.1%have moderate impairment.

Table 16: WHO Grading of impairment

WHO Grading	Left ear		Right ear	
	Frequency	Percent	Frequency	Percent
No impairment	130	70.7%	154	83.7%
Slight impairment	52	28.3%	28	15.2%
Moderate impairment	2	1.1%	2	1.1%
Total	184	100.0%	184	100.0%

The data indicates that none of the participants (100.0%) are experiencing tinnitus (ringing sound in the ears). Additionally, 96.7% of participants do not have difficulty hearing in a noisy environment, while a small percentage (3.3%) do report such difficulty.

Table 17: Are you experiencing a ringing sound (Tinnitus) in your ears?

	Frequency	Percent
No	184	100.0%

Table 18: Do you have difficulty hearing in a noisy environment?

Frequency	Percent	
Yes	6	3.3%
No	178	96.7%
Total	184	100.0%

The data shows that 96.7% of participants do not have difficulty hearing in either ear. However,1.6% report difficulty hearing in bothears, and another1.6%reportdifficulty hearing in one ear.

Table 19: Do you have difficulty hearing in one or both ears?

	Frequency	Percent
No	178	96.7%
Bothears	3	1.6%
Oneear	3	1.6%

DISCUSSION

ONIHL affects millions of workers globally, with high prevalence in industries like automobile, manufacturing, construction and mining. It leads to permanent hearing loss and other manifestations impacting worker's quality of life and productivity.

Prevalence of the 8.7% in this study indicate that still we need to put more efforts on conducting educational, awareness and training sessions on ONIHL.

We found that thought all of them are using PPE, some are still developing hearing loss, which indicates that may be because of improper use of the PPEs and prolonged exposure to loud noises (>85dB)

they are suffering from ONIHL. A similar study done in China in automotive industry by Chen Y, Zhang M, Qiu W, Sun X, Wang X, Dong Y, Chen Z, Hu W,[3] shows that HPD usage has a protective effect on the development of NIHL in workers. So training sessions on how to properly use PPE may be helpful in decreasing the prevalence of ONIHL.

In this study age group affected is mostly between 50-59 years of age. In the study done by Ranga, Rupenderk.,Yadav et.al on prevalence of occupational noise induced hearing loss in industrial workers, age group between 36-40 years was affected. Which indicates that increasing age might be one of the contributing factor in noise induced hearing loss apart from high noise areas.

The attenuation provided by the protector should comply with British Standard BS510866 (ISO 4869), and the basic design features should comply with BS 6344. Periodic Medical evaluation of hearing (audiometry) of exposed personnel for early detection of NIHL

Standard Threshold Shift

STS evaluation isdoneasper OSHA' sstandard, in worker's working in high noise areas, in which comparison of baseline audiometric report and current audiometric report is done, which helps in medical evaluation and potential treatment to address hearing damage early and prevent progression.

Training

Training sessions are conducted to create awarenesss about NIHL & demonstration of proper technique of using PPE's

Rehabilitation: Shift rotation or transfer to no noise areas in workshop in case of temporary hearing loss.

CONCLUSION

The findings of this study reveal that the workforce in the automobile industry is predominantly composed of middle-aged individuals with considerable work experience, particularly in noise-intensive environments such as the E 3/4 press shop. Despite the widespread and consistent use of Hearing Protection Equipment (HPE), which has significantly reduced noise exposure, a notable prevalence of Noise-Induced Hearing Loss (NIHL) still exists, affecting 8.7% of the participants. Audiometric evaluations indicate that while the majority have normal hearing, a small yet significant portion has developed slight to moderate hearing impairment. The hearing deterioration highlights the critical need for continuous monitoring, preventive strategies, and inclusive health interventions to protect the hearing health of this vulnerable workforce.

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