

**Original article:**

## **Effect of noise exposure on hearing – A comparative cross sectional study between professional drivers and office workers**

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### **Abstract:**

**Introduction:** Noise induced hearing loss is gradual and painless but unfortunately permanent. Pure tone audiometric test can be used as an investigatory tool to determine the type and degree of hearing loss. It also helps to screen the persons exposed to noise for hearing loss.

**Aim and Objective:** To find the prevalence rate of noise induced hearing loss, the hearing threshold levels for high frequency sounds in professional drivers and to compare with that of office workers.

**Materials & Methods:** This is a cross sectional study which was performed on professional drivers working in Tamil Nadu State Transport Corporation with minimum 8 years of driving experience, 8 hours of exposure to noise and compared with office workers working for 8 hours per day with minimum 8 years of experience. The prevalence rate was calculated by observing the characteristic notch at 4 kHz in Pure tone Audiometer. The hearing threshold levels were recorded for high frequency sound using Pure tone Audiometer.

**Results:** The prevalence rate of noise induced hearing loss was significantly higher ( $p < 0.001$ ) in professional drivers (64%) when compared to office workers (8%). The mean (SD) hearing threshold level for high frequencies was significantly higher in professional drivers when compared to office workers with  $p < 0.001$ .

**Conclusion:** Professional drivers have statistically significant higher prevalence rate of noise induced hearing loss and statistically significant higher hearing thresholds for high frequency sounds compared to office workers.

**Keywords:** Pure tone Audiometer, Hearing threshold, Notch at 4 kHz, professional drivers, office workers.

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### **Introduction**

Noise is one of the most pervasive problems in today's occupational environment affecting workers in various professions. Occupational noise induced hearing loss refers to a hearing loss caused by loud sounds experienced in a work place. The hearing loss is caused by exposure to loud sounds at 85 dB or above over a prolonged period of time<sup>[1]</sup>. Estimates from National Institute of Health<sup>[2]</sup> suggest that one third of hearing losses are caused due to noise exposure. Approximately 0.5 million population of Indian metropolitan cities are exposed to noise levels that are potentially

hazardous to their hearing. Hearing handicap is usually denoted as an average hearing threshold level of greater than 25 dB (A) for both ears at selected frequencies<sup>[3]</sup>. The source of most outdoor noise worldwide is mainly transportation systems including motor vehicle noise, air craft noise and rail noise. Of those, drivers are at high risk to be affected by traffic noise and other urban noise<sup>[4]</sup>. Adverse health effects due to noise include both auditory as well as non-auditory<sup>[5]</sup>.

Thus, noise is both a public health hazard and an environmental pollutant. Hence this work has been taken up to study the effect of years of noise

exposure on hearing and the prevalence of 4 kHz notch (the feature of noise induced hearing loss) among the professional drivers and compare it with office workers. It is hoped that this study will contribute to the knowledge on the effects of noise pollution on hearing and will improve the public awareness of the hazardous effects of noise.

**Aim & Objectives:**

1. To find and compare the prevalence of hearing impairments due to noise exposure (4 kHz notch) between professional drivers and office workers.
2. To compare the high frequency hearing thresholds of both ears between professional drivers and office workers

**Materials & Methods:**

A Comparative cross sectional study was designed with two groups, Group A with 50 subjects who are exposed to noise above the permissible limit and Group B with 50 subjects who are exposed to noise within permissible limits. Both of these groups selected were adult males.

**Inclusion criteria**

Group A included drivers of public transport, having minimum of 8 years driving experience and minimum of 8 hours of driving per day. Group B was selected from office workers with minimum of 8 years experience and who work for about 8 hours per day. The age group was between 30-50 years in both the groups.

**Exclusion criteria**

Diabetes mellitus, Hypertension, H/o Ototoxic drugs, Middle ear disease like CSOM, Otosclerosis and Head injury.

**Study design:** Comparative cross sectional study.

The study was preapproved by the ethical committee of our institution. The detailed procedure and purpose of the study was explained in the regional language and then an informed and written consent was obtained from each subject.

**Puretone audiometer:**

Hearing examination included pure tone air and bone conduction audiometry. Audiometric testing was conducted according to the guidelines of the American Speech Language Hearing Association in sound treated room using EDA-3 N 3-MULTI Diagnostic Audiometer, calibrated according to ANSI (ANSI S3 1989, ISO 389 1991, IEC 645) and equipped with TDH-39 P ear phones.

**Methods:**

A questionnaire was prepared and used to record the details of their age, education, years of driving and hours of driving. Clinical examination of the ear was done by an Otorhinolaryngologist which included examination for the presence of cerumen in the ear, structural assessment, mobility of the tympanic membrane, and abnormality of external auditory canal. Rinne's and Weber's test was done in all the subjects to study the air & bone conduction. Pure tone audiometry was performed for both professional drivers and office workers at the Institute of Physiology, Madurai Medical College, Madurai in a sound proof room.

Air conduction was tested with the better ear first with 1 kHz and then other frequencies were tested in the following order of 2, 4, 6, 8 kHz, 500 and 250 Hz. First the subject is made to familiarize to the tone by introducing it at an arbitrarily presumed suprathreshold level. Then slowly the intensity of the tone is decreased until the subject no longer hears the sound. In this procedure the tones are lowered in 10 dB steps and increased in 5 dB steps. The intensity at which the subject hears the tone for 50% of the time is marked as the threshold of hearing at that frequency. The second ear was tested in a similar manner and the hearing threshold was obtained for both ears by this conventional Hughson-Westlak technique and expressed in decibel hearing level units (dB HL). Bone conduction was tested in the subject by placing the

bone conduction vibrator with specification of Measurement of Bone vibrators (ANSI S3-13-1987) American National Standards Institute, 2002 over the mastoid in the same 5 up and 10 down method for all frequencies.

The results obtained were graphically represented and the audiometric symbols presented in the Guidelines of American Speech Language-Hearing Association, 1990 were used conventionally for plotting the pure tone audiogram.

| Modality        | Right Ear | Left Ear |
|-----------------|-----------|----------|
| Air conduction  | ○         | ×        |
| Bone conduction | <         | >        |

The hearing threshold values obtained from the audiogram was interpreted by following WHO grades of hearing impairment.

**Degree of hearing loss**

|                   |   |          |
|-------------------|---|----------|
| Mild              | - | 26-40 dB |
| Moderate          | - | 41-55 dB |
| Moderately severe | - | 56-70 dB |
| Severe            | - | 71-91 dB |
| Profound          | - | >91 dB   |

The pure tone averages for high frequencies 4,6 and 8 kHz were calculated for both right and left ears. The High frequency average is the criteria used to evaluate the function of hearing, since it is the frequency range known to be damaged maximally by excessive environmental noise and it is a region in which the effects of noise exposure first appear.

The most common configuration of Noise induced hearing loss is a bilateral, symmetrical sensorineural hearing loss with a notch at 4 kHz in the audiogram<sup>[6]</sup>.

**The reason for the occurrence of notch at 4 kHz:**

1. Anatomical location of 4 kHz area of the basilar membrane corresponds to that area of

basal turn of cochlea where it is firmly attached and therefore more prone for torsion and pressure changes in the perilymph.

2. Cochlea is more prone for vascular injuries in this area.
3. Reflex contraction of intratympanic muscles in response to loud sounds shift the sound towards higher frequencies.
4. Due to increased resonance of external auditory meatus, there is an increase in amplitude of sound waves in this frequency level.

**Data analysis:**

The results were analysed to estimate the prevalence of noise induced hearing loss by observing the presence of the characteristic notch at 4 kHz. None of the subjects (Group A& Group B) in this study were having hearing threshold level above 70 dB. Hence hearing threshold levels upto 70dB

(0-25 dB, 25.1-40 dB, 40.1-55 dB and 55.1-70 dB) were included and analysed in both groups.

**Statistical analysis:**

The comparison between the two groups was done by using one-way ANOVA test using SPSS (Statistical Package for Social Science) software, Sigma stat version 3.5. The significance was drawn at p value (probability) of < 0.05.

**Results:**

The statistical analysis of the details of the selected subjects are given in Table-1.

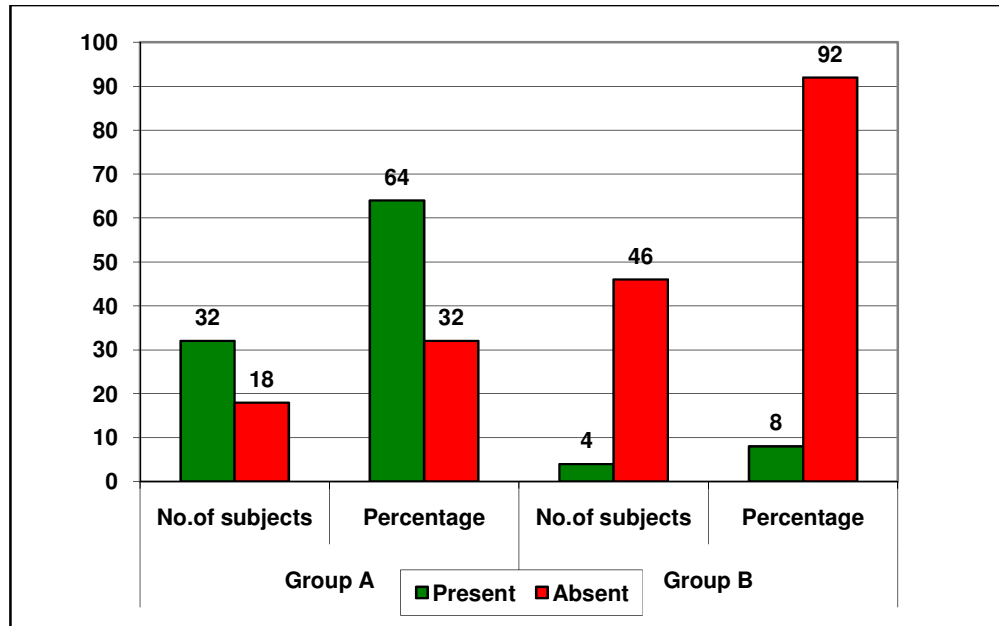
**Table1: Details of the selected subjects (Mean±SD)**

| Variables                                      | Group A(n=50)<br>Mean± SD | Group B (n=50)<br>Mean ±SD | P value |
|--|---------------------------|----------------------------|---------|
| Age (years)                                    | 39.38 ±5.36               | 39.88 ±4.92                | 0.628   |
| Height (cm)                                    | 163.08 ± 6.29             | 161.42 ± 7.24              | 0.224   |
| Weight (kg)                                    | 65.88 ± 5.98              | 62.38 ± 8.46               | 0.019   |
| Systolic B.P (mm Hg)                           | 129.2 ± 8.45              | 130.12 ± 9.59              | 0.612   |
| Diastolic B.P (mm Hg)                          | 81.08 ± 6.02              | 78.72 ± 5.65               | 0.046   |
| Years of exposure to noise                     | 13.70 ±4.92               | 10.54 ±2.95                | <0.001  |
| Hours of exposure to noise/ day                | 8.92 ±1.31                | 8.0 ±0.0                   | < 0.001 |
| High frequency hearing threshold Right ear(dB) | 29.24 ±8.08               | 19.62 ±6.90                | < 0.001 |
| High frequency hearing threshold Left ear (dB) | 29.67 ±10.29              | 19.93 ±6.23                | < 0.001 |

P value < 0.05 is significant.

Mean age for the two groups A and B were 39.38±5.36 and 39.88±4.92 years respectively. There was no significant difference between Group A and Group B with respect to age, height, weight and blood pressure whereas the selected subjects between the groups have significant difference (p<0.001) with respect to years of exposure, hours of exposure and threshold level.

**Fig1: Prevalence of Noise induced hearing loss (4kHz notch) between Group A & Group B**

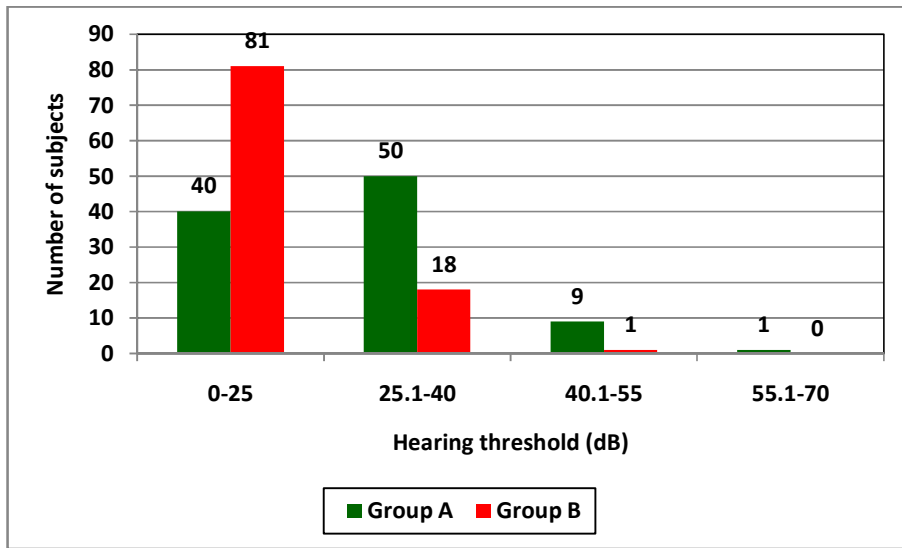


Out of 50 persons in Group A, 32 persons (64%) were found to have audiometric evidence of notch at 4 kHz, a feature characteristic of noise induced hearing loss, when compared to the Group B where only 4 persons (8%) have a notch at 4 kHz and this is statistically significant with  $p < 0.001$  by chi square test.

**Table2: Comparison of high frequency hearing threshold of both ears between Group A & Group B**

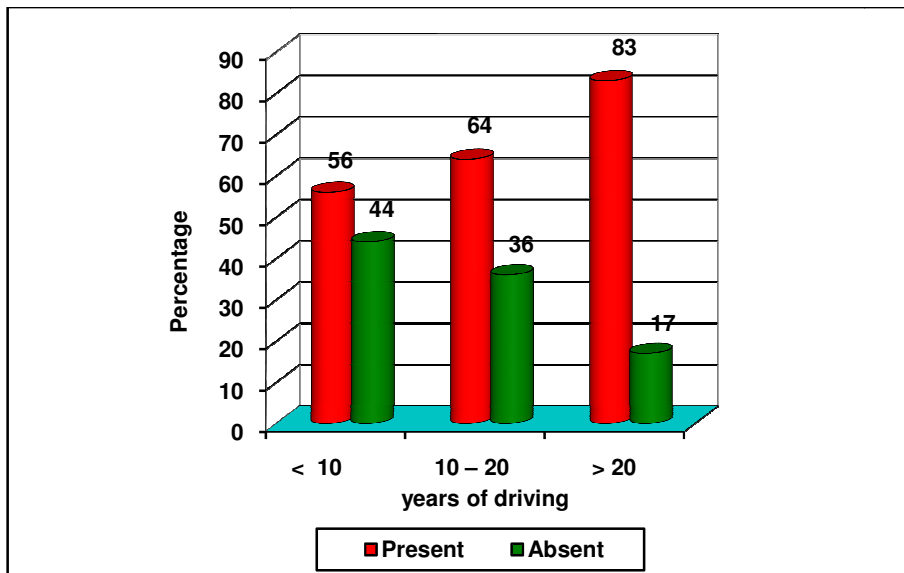
| Hearing threshold (dB) | Right Ear           |         | Left Ear            |         |
|------------------------|---------------------|---------|---------------------|---------|
|                        | Group A             | Group B | Group A             | Group B |
| 0 – 25                 | 19                  | 41      | 21                  | 40      |
| 25.1 – 40              | 28                  | 8       | 22                  | 10      |
| 40.1 – 55              | 3                   | 1       | 6                   | 0       |
| 55.1 – 70              | 0                   | 0       | 1                   | 0       |
| Mean                   | 29.24               | 19.62   | 29.67               | 19.93   |
| SD                     | 8.08                | 6.90    | 10.29               | 6.23    |
| P value                | < 0.001 significant |         | < 0.001 significant |         |

**Fig 2: High frequency hearing threshold between Group A&Group B**



In both ears the high frequency hearing threshold is higher in Group A when compared to Group B. The values indicate that hearing damage of drivers is expected to occur sooner at high frequencies.

**Fig 3: Influence of years of driving on hearing loss (4kHz notch)**



The hearing loss positively correlates with duration of exposure to noise. As the years of exposure to noise increases, the hearing threshold also increases linearly in high frequency range in both ears among the drivers. The percentage prevalence 4 kHz notch increases with increasing years of noise exposure.

### **Discussion:**

High levels of noise have a significant impact on the auditory system and overall physiology of humans<sup>[7]</sup>. Present study revealed that among the occupational population, the driver groups were found to have the highest risk of traffic noise induced hearing loss. It has also been found that there is a selective sensorineural hearing loss which affects the high frequency sounds first and is seen as a notch at 4 kHz in pure tone audiogram(Fig 1). Similar result is observed by Leonog&Laortanakul 2003<sup>[8]</sup>.

According to S. Williams, Mc Bride DI2001<sup>[6]</sup> Prevalence of noise induced hearing loss was identified by the presence of a notch in either ear. Their study also confirmed that with exposure to steady noise, the first well established clinical and valuable sign in confirming the diagnosis was the notch in the audiogram, maximal at 4 kHz. In the present study also, the increased prevalence of hearing loss in noise exposed group was identified by the notch at 4 kHz and 64% of the drivers showed this valuable sign in their audiogram(Fig 1).

From this study, it is evident that the prevalence rate of hearing loss is high in professional drivers (Fig 1) and it increases with the increase in the years of noise exposure (Fig 3). This is in line with the findings of Imitraz Siddique & Riaz Siddique 2008<sup>[9]</sup> and Lt Col S Nair & Kashyap 2009<sup>[10]</sup> on prevalence of hearing loss in noise exposed group. He observed statistically significant increase in hearing loss with increase in duration of noise exposure.

Present study showed significantly increased overall hearing threshold levels of professional drivers as compared to office workers.(Table

2&Fig 2) This finding is similar to that of the previous study done on "Excess risk estimates of hearing impairment of Indian professional drivers," by Majumder et al 2009<sup>[11]</sup>.

Gloriget al 1962<sup>[12]</sup> and Rejina et al 2008<sup>[13]</sup> reported that noise exposed persons had significantly more hearing loss over the high frequency range than office workers in the same age categories. We have also got similar results showing higher prevalence of high frequency hearing loss in professional drivers when compared to office workers.

In the last few years, progress has been developed in various potential therapeutic approaches in addition to the preventive measures. It has been shown that hair cell loss mediated by noise may be prevented by antioxidants<sup>[14]</sup>, inhibitors of intracellular stress pathways<sup>[15]</sup>, neurotropic factors, neurotransmission blockers<sup>[16]</sup>, and T-type calcium channel blockers. Recently the stem cells<sup>[17]</sup> have been used in inner ear research in the hope that they will ultimately differentiate into hair cells and auditory neurons.

### **Conclusion:**

Present study has confirmed that noise exposed personnel are at risk of hearing loss. It may be concluded that occupational hazards of professional driving significantly increased the hearing threshold levels of drivers as compared to office workers. Public awareness of the hazardous effects of noise is low. To emphasize on this, the last Wednesday of April every year has been declared "International Noise Awareness Day" (INAD). Hence Pure tone audiometry, a basic investigation can be used to screen the professional drivers for occupational hearing loss. They can be monitored for early onset of any noise induced hearing loss and educated for the prevention of the same.

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