Section: ENT

Original Research Article

BURDEN AND DETERMINANTS OF NOISE INDUCED HEARING LOSS AMONG BUS DRIVERS OF CHENNAI – A CROSS SECTIONAL STUDY

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ABSTRACT

Background: Occupational noise-induced hearing loss (NIHL) is emerging as a significant global health issue, resulting in disabling hearing impairments in working adults, especially in high-exposure occupations such as transportation and industrial sectors1. Chronic exposure of noise generated by vehicle engines, traffic congestion, road conditions, and environmental noise, place them at increased risk of noise-induced hearing loss (NIHL). Early identification of auditory changes among professional bus drivers is essential for preventing irreversible hearing impairment and maintaining occupational safety. The objective is to determine the prevalence of hearing loss among transport drivers using pure tone audiometry and to evaluate its association with demographic factors, occupational exposure, comorbidities and use of hearing protection devices.

Materials and Methods: 160 bus drivers undergoing routine medical examination were included in a cross sectional study conducted at a tertiary care centre in Chennai. Data regarding age, sex, driving experience, comorbities like Diabetes mellitus, Hypertension, smoking, alcohol consumption and use of hearing protection devices were collected using a structured proforma. The participants underwent otoscopic examination and pure tone audiometry. Clinically significant hearing loss was defined as a mean pure tone average (PTA) greater than 25 dB HL. Early NIHL was determined by the presence of a characteristic high-frequency slopes and audiometric notch. Statistical analysis was performed using descriptive statistics, Chi-square test, and multivariable logistic regression, with $p < 0.05$ considered statistically significant.

Results: The mean age of participants was 46.8 ± 11.0 years, with a mean driving experience of 20.8 ± 7.7 years. Early NIHL and minimal hearing loss were detected in 73.1%. Hearing loss and was significantly associated with increasing age. Also, clinically significant hearing loss (PTA>25 dB HL) was observed in 35.6% of participants. Use of hearing protection devices was significantly associated with a lower prevalence of hearing loss among transport drivers. Hearing loss was observed in 49 of 117 (41.9%) drivers who did not use hearing protection devices ($\chi^2 = 7.54$, $p = 0.006$) Diabetes mellitus was present in 71 of 117 drivers (60.7%) with hearing loss when compared with 9 of 43 drivers (20.9%) with normal hearing, thus demonstrating a statistically significant association between diabetes and hearing impairment ($p < 0.001$).Years of experience was also significantly related to audiometric notch and High frequency slope ($p<0.001$). No statistically significant association was observed between clinically significant hearing loss and smoking ($p = 0.745$) or alcohol consumption ($p = 0.821$).

Conclusion: Hearing impairment is highly prevalent among bus drivers, with advancing age, prolonged work hours, and longer work experience identified as key risk factors. They exhibit a huge burden of occupational hearing impairment with early audiometric changes. Hence, health education, and enforcement of protective measures are essential to reduce occupational hearing loss.
Keywords: Hearing loss, Noise-induced hearing loss, bus drivers, Pure tone audiometry, Occupational health.

INTRODUCTION

Noise pollution permeates every facet of modern life and poses as an omnipresent risk. It can cause stress, sleep alterations, hormonal imbalance, heart disease thereby reducing the functional wellbeing.[1,2]. Compared to the various causes of hearing impairment, noise-induced hearing loss (NIHL) remains an important yet preventable occupational health problem. Hearing loss affects approximately 18% of the population all over the world and occupational noise exposure is considered a major modifiable risk factor for auditory impairment.[3].

Such exposure to constant noise at hazardous levels can lead to noise-induced hearing loss (NIHL), which is often irreversible, progressive and bilateral.[4].Bus drivers constitute an occupational group with varying levels of environmental and vehicular noise exposure during their working hours. In addition to occupational noise exposure, advancing age, systemic illnesses such as diabetes mellitus and hypertension, smoking, and alcohol consumption may further increase the risk of hearing impairment in this population.

NIHL is often overlooked due to its painless progression, yet pose a considerable risk, particularly for those working in loud environments, such as bus drivers. Early detection becomes challenging as NIHL typically starts by affecting the frequencies greater than normal conversation.[5] Thus, NIHL may remain unnoticed in the early stages when the speech frequencies get preserved despite the presence of high-frequency hearing loss. Hence, these drivers may be experiencing prolonged noise exposure without noticing the impairment unless tested audiometrically.[6] Early identification of these changes through audiological evaluation provides an opportunity for intervention and preventive measures.[7]

There are various studies demonstrating the hazardous risk of NIHL across various industries. Yet, a notable gap was observed in research focusing on Bus drivers, particularly in South India.[8] The existing literature predominantly focuses on truck drivers, overlooking the unique noise exposure patterns faced by Bus drivers.[9] Considering their prolonged exposure to high noise levels, extended driving hours, poor road conditions, and lack of access to hearing protection, this gap becomes crucial to be analysed. Despite the lacking awareness among the drivers about noise hazards along with their limited use of ear protection reinforce the need for improved safety practices.[10]

The present study mainly focuses to determine the prevalence of hearing loss among transport drivers using pure tone audiometry and to evaluate its association with demographic characteristics, occupational exposure, comorbidities, lifestyle factors, and use of hearing protection devices.

MATERIALS AND METHODS

Participants: The study followed a cross-sectional approach to analyse the prevalence of hearing loss, specifically NIHL, among transport drivers. We included a total of 160 transport drivers across different age groups and years of work experience. To focus the study on NIHL, drivers aged 20–60 years who consented to participate in the study were included and those with a previous history of ear disease or hearing impairments were excluded.

Sample size calculation: The previously reported prevalence of hearing loss among transport drivers was 18.1%. The sample size was estimated using the Cochran's formula yielding a final sample size of 160 participants.

Data collection: The study duration was 7 months from October 2025 to May 2026 after obtaining approval from the Institutional Ethics Committee. (EC/NEW/INST/2022/2769). A questionnaire was used to collect social and demographic details such as age, education status, hours of work per day and work experience. Smoking and alcohol consumption history along with Information regarding the history of comorbid statuses were recorded.

Smith Hearing Severity Questionnaire was used to assess the hearing status subjectively in order to evaluate the hearing-related symptoms. Based on the total score obtained, participants were categorized as having mild (score 6–10), moderate (score 11–20), or severe (score >20) hearing handicap.

Followed by a thorough otoscopic examination, they underwent pure tone audiometry in a sound treated environment. Hearing thresholds for frequencies ranging from 250 Hz to 8 kHz were recorded for each ear and audiometric notches & high-frequency slopes were also assessed.

PTA greater than 25 dB HL was defined as clinically significant hearing. The presence of a characteristic notch at 4 kHz was considered highly suggestive of early noise-induced hearing loss.11An audiometric pattern where hearing thresholds tend to worsen with increasing frequency, above 2 kHz is called High frequency sloping which is related to Noise induced hearing loss.[12]

The severity of hearing loss was graded based on Goodman classification of PTA values as normal is less than 25 dB HL, mild hearing loss is 26 to 40 dB HL, moderate hearing loss is 41 to 55 dB HL, moderately severe loss ranges from 56 to 70 dB HL, severe is between 71 and 90 dB HL and profound hearing loss is defined as loss more than 90 dB HL.[13]

Data analysis: The collected data were entered into Microsoft Excel and Statistical Package for the Social Sciences (SPSS) version 26 was used for data analysing.

RESULTS

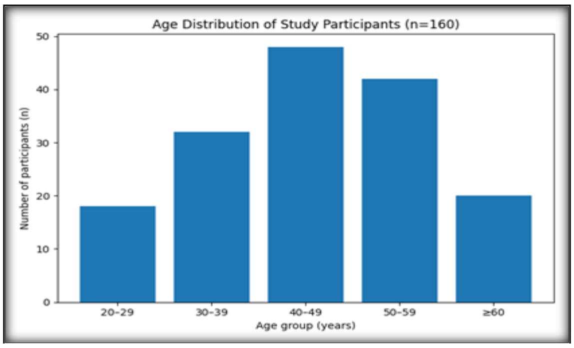


Figure 1: Age Distribution Of Study Participants.

Among the 160 participants included in the study, their mean age fell in the range 46.8 ± 11.0 years, The majority of participants belonged to the 40–49 years age group (30.0%), followed by the 50–59 years age group (26.3%). [Figure 1] The participants were all males.

In the study participants, 106 participants (66.3%) were found to have atleast one comorbidity. 80 participants (50.0%) were found to have diabetes mellitus and hypertension was reported by 68 participants (42.5%). Both diabetes mellitus and hypertension coexisted in 42 participants (26.3%), whereas 54 participants (33.7%) had no reported comorbidities. [Figure 2]

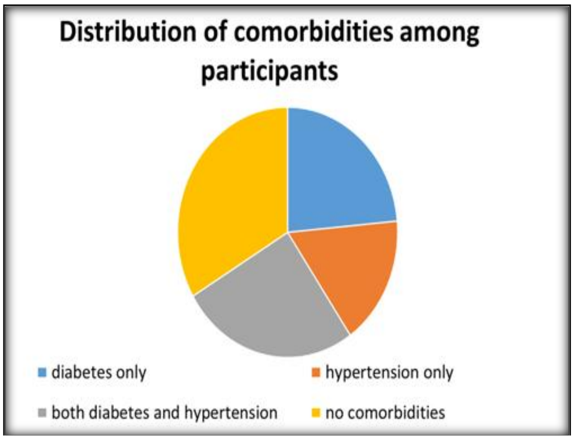


Figure 2: Distribution of comorbidities among study participants.

Table 1: Age Distribution among Participants

AGE GROUP (years)	Number (n)	Percentage (%)
20–29	18	11.3
30–39	32	20.0
40–49	48	30.0
50–59	42	26.3
≥60	20	12.5

Table 2: Distribution of comorbidities among participants

Comorbidity status	Number (n)	Percentage (%)
Diabetes mellitus only	38	23.7
Hypertension only	26	16.3
Both diabetes and hypertension	42	26.3
No comorbidity	54	33.7
Total	160	100

The Smith's Hearing Severity Questionnaire showed that Mild hearing handicap (score 6–10) was observed in 33 participants (20%), while the remaining 127 participants (79.4%) reported to have normal hearing (score <5). [Table 3] The mean Smith's Hearing Severity Score among the study participants was 3.68 ± 1.62.

Table 3: Smith's Hearing Severity Questionnaire Scores

Smith score category	Score range	Number (n)	Percentage (%)
Normal hearing handicap	≤5	127	79.4
Mild hearing handicap	6–10	33	20.6
Moderate hearing handicap	11–20	0	0
Severe hearing handicap	>20	0	0
Total		160	100

Table 4: Association of Smiths severity scores to hearing loss

Smith score category	Hearing loss present (n=117)	Normal hearing (n=43)	Total
Normal score (≤5)	92	35	127
Mild handicap (6–10)	25	8	33
Total	117	43	160

There was no statistically significant association between Smith questionnaire scores and audiometric hearing loss ($\chi^2 = 0.026$, $p = 0.871$), which suggests that many drivers remained asymptomatic despite evidence of hearing impairment on audiometry.

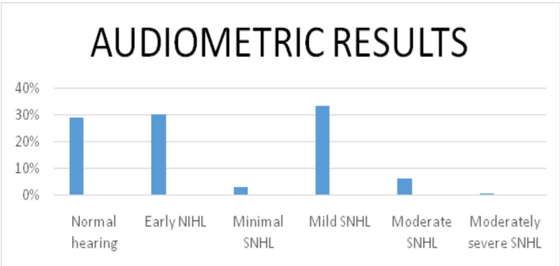
The Pure tone audiometric results revealed that mild sensorineural hearing loss was observed in 53 participants (33.1%), and early noise-induced hearing loss (NIHL) in 48 participants (30.0%). 10 participants (6.3%) had moderate sensorineural hearing loss. Minimal sensorineural hearing loss was noted in 5 participants (3.1%), and moderately severe sensorineural hearing loss was found in 1 participant (0.6%) thus hearing impairment was found in a total of 117 participants. [Table 4]

Table 5: Audiometric Results

Audiometric results	Number (n)	Percentage (%)
Normal hearing	43	26.9
Early NIHL	48	30.0
Minimal SNHL	5	3.1
Mild SNHL	53	33.1
Moderate SNHL	10	6.3
Moderately severe SNHL	1	0.6
Total	160	100

Table 5: noise induced hearing loss characteristics

Audiometric feature	Number (n)	Percentage (%)
Presence of 4 kHz notch	55	34.4
Absence of 4 kHz notch	105	65.6
High-frequency SNHL present	86	53.8
High-frequency SNHL absent	74	46.2



Noise induced hearing loss was observed as a characteristic 4 kHz audiometric notch, which was observed in 55 participants (34.4%). High-frequency sensorineural hearing loss which is also associated with NIHL was found present in 86 participants (53.8%) [Table 5].

Also Participants with a characteristic notch had a significantly higher mean age compared with those without a notch ($p < 0.001$). Diabetes mellitus was prevalent in 40 of the 55 participants (72.7%) with an audiometric notch, compared with 40 of the 105 participants (38.1%) without a notch, demonstrating a significant association between diabetes mellitus and the presence of a 4 kHz notch (Chi-square = 15.96, $p < 0.001$)

Similarly, hypertension was present in 32 of the 55 participants (58.2%) with a 4 kHz notch, compared with 36 of the 105 participants (34.3%) without a notch, indicating a significant association between hypertension and the presence of an audiometric notch (Chi-square = 7.48, $p = 0.006$). [Table 6]

Table 6: association of diabetes and hypertension to 4kHz notch

Comorbidity status	4 kHz notch present n (%)	4 kHz notch absent n (%)	Total
Diabetes mellitus only	16 (42.1%)	22 (57.9%)	38
Hypertension only	8 (30.8%)	18 (69.2%)	26
Both diabetes and hypertension	24 (57.1%)	18 (42.9%)	42
No comorbidity	7 (13.0%)	47 (87.0%)	54
Total	55	105	160

Increasing age showed a significant association with hearing loss. Drivers with hearing impairment had a higher mean age compared with those with normal hearing ($p < 0.001$). Drivers with hearing loss also had longer driving experience compared to those with normal hearing thresholds ($p < 0.001$). These findings prove that prolonged occupational exposure to vehicular noise has significant association with the development of hearing loss.

Diabetes mellitus was present in 71 of 117 drivers (60.7%) with hearing loss when compared with 9 of 43 drivers (20.9%) with normal hearing, thus demonstrating a statistically significant association

between diabetes and hearing impairment (p < 0.001).
Among the 117 drivers with hearing impairment hypertension was found in 62 participants (53.0%) while hypertension was seen only in 6 of 43 drivers (14.0%)with normal hearing, indicating a significant association between hypertension and hearing loss (p < 0.001) [Table 7]

Table 7: Association between Diabetes and Hypertension with hearing loss

Comorbidity status	Hearing loss present n (%)	Normal hearing n (%)	Total
Diabetes mellitus only	33	5	38
Hypertension only	18	8	26
Both diabetes and hypertension	38	4	42
No comorbidity	28	26	54
Total	117	43	160

Only 42(26.3%) participants reported to the regular usage of hearing protection devices. Also Hearing loss was present in 100 of 118 drivers (84.7%) who did not use hearing protection devices compared with 17 of 42 drivers (40.5%) who used hearing protection regularly. Thus there is a statistically significant association observed between non-use of hearing protection devices and hearing loss
(Chi-square = 28.68, p < 0.001). [Table 8]

TABLE 8: ASSOCIATION BETWEEN HEARINGPROTECTION DEVICE USE & HEARING LOSS

Use of hearing protection devices	Hearing loss present	Normal hearing	Total	p value
Regular use	17	25	42	
No use	100	18	118	
Total	117	43	160	<0.001

Thus the results quantifies that, the overall advancing age, longer occupational noise exposure, presence of comorbidities like diabetes mellitus and hypertension, and non-use of hearing protection devices were significantly associated with hearing loss among transport drivers.

DISCUSSION

The study clearly reveals a direct link between noise exposure and hearing impairment among transport drivers, with 73.1% of participants demonstrating an audiometric evidence of hearing loss. Of which Early noise-induced hearing loss and mild sensorineural hearing loss constituted the majority, indicating that auditory insult due to such high vehicular noise begins much earlier than clinically perceived by most drivers.
In the past, only a few studies have focused on noise exposure among drivers. A study by Patwardhan et al,[14] on bus drivers, revealed that 89% of bus drivers had audiogram detectable hearing loss when exposed to noise levels above 80 decibels during work Likewise, Bagla et al. found that 36% of bus drivers in North India suffered from hearing loss when exposed to noise levels exceeding 85Db.[15]
The Smith Hearing Severity Questionnaire identified subjective hearing complaints in a smaller proportion of participants, yet the scores did not establish a link with the audiometric changes, as most drivers remain asymptomatic inspite of having hearing loss, which supports the fact that early NIHL predominantly affects high frequencies, while preserving their regular conversation as supported by Aryal et al.[16]
The characteristic 4 kHz audiometric notch which is hallmark of NIHL was identified in almost one-third of the participants, while high-frequency hearing loss was noted in 53% of the study population, indicating that cochlear damage may occur even before conversational frequencies become affected. These findings coincide with the study done by Mehrotra et al. (2025), which showed a high prevalence of early high-frequency audiometric abnormalities among professional drivers.[17]
The bilaterality of hearing loss and the specific involvement of high frequencies in the audiometric patterns, indicates that age was a significant determinant, which becomes consistent with the epidemiological data showing increasing age itself is the single main risk factor for adult-onset hearing loss. Due to cumulative cochlear degeneration and heightened susceptibility to environmental shocks.[18–21]
Additionally strong associations were found between driving experience and hearing loss. As it directly reflects upon the cumulative years of occupational noise exposure. Similar observations were by Manar et al revealing a linear relationship between professional drivers with continuous environmental noise and development of hearing loss.[22]
Participants with comorbidities especially the coexistence of both diabetes mellitus and hypertension demonstrated the highest prevalence of hearing loss, owing to the well-known fact that microangiopathic changes affects the cochlear blood supply and resulting in metabolic injury to the auditory pathway making them susceptible to both NIHL and age related hearing loss.
In the current study, only a few drivers reported using hearing protection on a regular basis. Compared to regular users, drivers who did not wear hearing protection had significant hearing loss. This aligns with the concept that consistent use of hearing protection devices results in lowering the

risk of noise-induced hearing loss as stated by Akbari et all (2024).[23] These results highlight the significance of audiological screening, awareness campaigns among transport workers, and hearing conservation programs.

Limitations and future directions: The study focuses on only male bus drivers working within Chennai city limits, hence the generalizability of the results to either female groups or regions with different demographic characteristics gets limited. The study uses Pure Tone Audiometry (PTA) as the measuring tool for hearing loss which is still a subjective test, depending on participant's cooperation. Hence, variations in threshold estimation are inevitable. Confounders like ototoxicity, use of recreational listening devices were not excluded and use of self reported questionnaire may often give rise to recall bias.

Usage of Hearing protection devices like earplugs and earmuffs during work hours is to be implemented. Additionally, occupational health programs must be promoted to educate drivers regarding noise risks, proper protection devices use and the importance of periodic hearing assessments.

CONCLUSION

The study highlights the high burden of early yet clinically significant hearing impairment among bus drivers, with age, prolonged occupational noise exposure, diabetes mellitus, hypertension, and non-use of hearing protection devices identified as important associated factors. This high prevalence of asymptomatic high-frequency hearing loss with hallmark audiometric changes necessitates the need for periodic audiological screening along with increased awareness and strict enforcement of occupational safety measures to mitigate the long-term auditory health risks among bus drivers.

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