Assessment of personal noise exposure levels of auto-rickshaw drivers on Chennai traffic roads

Daisy Edwin[1,2], R. Sugaraj Samuel[2*], R Madhan Chandrasekar[1]

[1] Sri Ramachandra Faculty of Audiology and Speech Language Pathology, SRIHER-DU, Porur, Chennai, Tamil Nadu, India.

[2]The New College (Affiliated to University of Madras), Royapettah, Chennai, Tamil Nadu, India.

***sugarajsamuel@gmail.com**

Abstract - Traffic noise is a significant contributor to noise pollution that has detrimental effects on human health. Due to the alarming increase in environmental noise pollution, various organisations urge for the introduction of noise exposure limits and permitted levels. Auto rickshaws are the primary means of transportation in cities such as Chennai, carrying considerable responsibilities. In this cross-sectional study, 121 healthy auto-rickshaw drivers from various regions of Chennai were recruited. The goal of this study was to determine the personalized noise exposure level of auto-rickshaw drivers who are constantly exposed to traffic noise. Study participants were equipped with noise dosimeter instrument to assess their personal noise exposure level throughout the 8-hour working shift. The continuous equivalent noise exposure levels (LAeq, 8h) for drivers ranged from 77.1 to 101.4 dB(A), revealing elevated noise exposure on Chennai urban roads. The corresponding noise dose percentage ranged from 5.5% to 291.9%. The measured noise levels were found to be high above the recommended limit of OSHA, NIOSH, EPA and WHO standards. The study revealed that the noise levels in the Chennai urban roads are high. Interventions to facilitate education on auditory health, raising awareness on the effects of prolonged exposure to noise should be prioritized among drivers.

Keywords: Traffic noise, sound exposure, Equivalent continuous sound pressure level, noise dosimeter, recommended exposure limits.

I. INTRODUCTION

Traffic noise is a major source of noise pollution that has a negative impact on human health, especially in densely populated metropolitan areas. Chennai, with a population of 11.2 million people, is one of India's noisiest metropolitan cities. The Central Pollution Control Board (CPCB) monitors noise levels at monitoring stations located throughout India's major cities. It was observed that Chennai was the noisiest of India's six major cities in 2018 [1]. The number of registered motor vehicles surpassed twenty-three million in the 2018-2019 financial year [2]. According to the record, the total number of automobiles of all categories topped 2.56 crore in Chennai city as on March 31, 2018 [3]. There is almost one lakh registered auto rickshaw drivers in urban Chennai [4]. Studies reported that vehicle noise levels from engines and horns are the most concerning in urban areas, accounting for up to 60% of overall noise pollution [5]. Prolonged exposure to loud noises for several hours can damage sensitive structures in the ear, resulting in Noise Induced Hearing Loss (NIHL) [6]. In urban areas and cities like Chennai, auto rickshaws are the primary and common mode of transport. According to several studies, the performance of professional drivers carries a considerable deal of responsibility, and this profession is characterised by the daily difficulties that the driver must overcome while at work [7]. The auto drivers are very much subjected to high level of noise exposure continuously during their duty due to the nature of work. Moreover, their work pattern and exposure to noise in the community is hazardous. The situation further worsens due to the traffic congestion, honking and poor maintenance of roads. Presence of continuous noise above 85 dB(A) in a workplace may injure worker's auditory system and cause hearing impairment [8].

In view of the alarming increase in environmental noise pollution, many countries recommend to implement noise exposure legislation, permissible noise levels, regulations or standards [9]. Several organisations have established recommended noise exposure limits in an effort to prevent noise-induced hearing loss which include Occupational Safety and Health Administration (OSHA), National Institute of Occupational Safety and Health (NIOSH), World health Organization (WHO), Environmental Protection Agency (EPA) and the European Union (EU). OSHA has established 90dBA as the time-weighted average

 DOI : 10.35291/2454-9150.2023.0202

(TWA) for an 8-hour work day of noise exposure, while NIOSH has established 85dBA and the Environmental Protection Agency and World Health Organisation have set the limit at 75 dB(A) [10]. Noise exposure monitoring using noise dosimeter provides traffic noise levels in different areas or location for the particular duration. Even though noise has many harmful impacts on the day to day functional activities on transportation sector workers, adequate importance has not been given in urban areas and cities like Chennai. Air pollution and water pollution has attracted majority of researches but little attention has been paid in the area of noise pollution. Very few studies were carried out in India on the prevalence of noise induced hearing loss among vehicle drivers and especially three wheeler auto rickshaw drivers. Moreover, noise exposure recommendations are mostly considering only the intensity of the sound level and not the duration of exposure to sound. The relationship between the intensity and duration of noise exposures relies on the equal energy hypothesis. Traffic noise also contribute to accidents; increases communication difficulties, affects attention and concentration and primarily increases additive stress to the worker. This current study aims to assess the personalised noise exposure levels of auto-rickshaw drivers on Chennai busy roads.

II. MATERIALS AND METHOD

Daily noise exposure monitoring and measurement

A cross-sectional survey was conducted among auto-rickshaw drivers in several locations of Chennai from February 2021 to March 2022. A total of 121 full-time regular auto-rickshaw drivers from Chennai urban areas were participated in the study. Participants enrolled in this study were provided with the noise dosimeter equipment to measure the personal noise exposure level throughout the day. Instructions were given to each participants regarding how to place the dosimeter and microphone correctly. Drivers carried the personal noise dosimeter in their pockets and the microphones fixed near their shirt collar for the full working shift (8 hours). The equivalent sound level (Leq), time weighted average (TWA) and daily noise dose percentage of each worker was measured using SoundTek-130 noise dosimeter model using “A” weighting network and fast mode setting while the drivers were driving their auto-rickshaws during their work shift. The microphone measures the noise level and delivered the information to the dosimeter. At the end of the driver’s work shift, the investigator downloaded the noise exposure data into a computer. The contribution of total daily noise exposure was recorded for analysis. Battery replacement and dosimeter calibration were provided by the research investigator.

III. RESULTS

Traffic noise level measurement were carried out in Chennai busy roads using noise dosimeter. Table 1 provides a summary of the 8-hour personal noise exposure measurement data describing the level of traffic noise among auto-drivers in Chennai's urban areas. The mean age of the study participants was 42.17 $\pm$ 9.03. The mean number of hours worked per day in the noisy environment by the participants were 9.96 $\pm$ 2.10.

Distribution of personal sound exposure levels

A total of 121 personal noise dosimetry measurements were attempted of which 102 were successful. Unsuccessful measurements resulted from instrument failure, battery drainage and premature dosimeter removal by workers. Noise measurements were made using the personal noise dosimeter to evaluate the average exposure of drivers to noise during an 8-hour day time work shift, when there was a reasonable traffic activity (in general 8 a.m to 5 p.m). Noise dosimeter data were downloaded and analysed for 102 participants. Table 2 displays the average noise pollution indices viz. LEP, d, LEQ, SEL, LAVG, DOSE, TWA, L5, L10, L50, L90, L95, RMS maximum level, RMS minimum level and Peak expedience level of drivers in Chennai urban regions.

Table 1: Summary of noise exposure levels were measured using noise dosimeter

Parameters	Mean	S.D	Min	Max
(LEP, d) (in dB)	89.5	5.6	77.1	99.6
(LAeq, 8h) (in dB)	90.4	5.9	77.1	101.4
(SEL) (in dB)	134.1	5.6	121.6	144.2
(LAVG) (in dB)	91.7	4.8	83.2	101.5
Noise Dose (in %)	84.8	61.7	5.5	291.9
TWA (in dB)	86.4	6.6	69.1	97.7
L5(in dB)	96.0	5.8	83.2	106.3
L10 (in dB)	93.2	10.8	3.0	104.6
L50 (in dB)	83.5	8.5	50.0	99.1
L90 (in dB)	57.0	10.1	50.0	88.5
L95 (in dB)	54.3	7.0	50.0	84.3
RMS MAX LEVEL (in dB)	107.1	3.5	96.3	110.2
RMS MIN LEVEL (in dB)	50.7	6.3	50.0	112.8
PEAK EXPEDIENCE LEVEL (in dB).	125.4	6.5	110.4	141.8

Magnitude of sound level in the urban areas of Chennai roads

The continuous equivalent noise exposure levels (LAeq,8h) of the drivers were observed in the range of 77.1 to 101.4 dB (A) respectively, and the results indicated that drivers at the Chennai urban roads were exposed to elevated noise levels (Figure 1).

 DOI : 10.35291/2454-9150.2023.0202

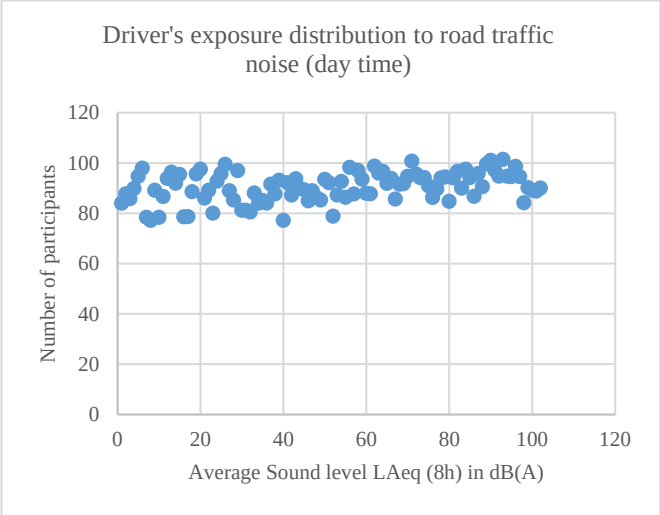

Figure 1: Distribution of the study participants' equivalent continuous sound pressure level throughout an 8-hour period.

It can be observed from the noise monitoring data that 52% of participants exceeding the noise levels more than 90 dB(A) and 82% of participants exceeded noise levels more than 85 dB(A). The Lmax exceeded 105 dB(A) in 73% of participants, and peak levels were 120 dB(A) or higher in 82% of samples.

Distribution of participant's recorded noise dose values

Figure 2 displays the study participants' 8-hour equivalent measured noise dose in percentage value. The minimum and maximum noise dose ranged between 5.5% to 291.9 % among auto-rickshaw drivers. The mean full-shift TWA for noise was 86.4 dB(A) (S.D 6.6) with samples ranging from 69.1 dB(A) to 97.7 dB(A). It was observed that the results of time weighted average were highly variable during the measurement period.

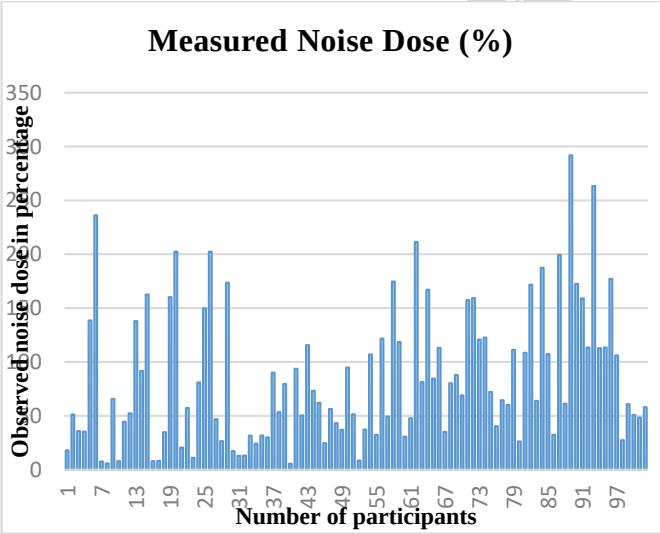

Figure 2: Cumulative distribution of noise dose (in%) recorded in drivers at different locations.

Noise measurement report from each participant was found to contain occasional peaks and vary more in levels. This simply demonstrated that although the noise levels during any period of the day were generally constant but the presence of single event noise was sufficient to affect the values of different noise percentile levels and consequently the traffic noise index. This is due to the overpopulated road ways with bad conditions, frequent honking and poor traffic management.

Participant's noise exposure compared with WHO, EPA, NIOSH, and OSHA environmental noise exposure standards in dB(A).

Figure 3 represents the practical comparison of equivalent continuous noise levels (LAeq,8h) of drivers with significant noise exposure standards. The result of the study observed that the average LAeq, (8h) was 90.4 dBA with a maximum of 101.4 dBA and minimum of 77.1 dB(A) The drivers of the current study were exposed to noise levels above the recommended permissible limits prescribed by the WHO, EPA, NIOSH, OSHA. The overall results indicate that 100% of participants are exposed to noise levels higher than 75 dB(A) which is higher than the permissible limit recommended by WHO and EPA. 82% of study participants were subjected to noise levels greater than 85 dB(A), which exceeds the allowable limit advised by NIOSH. Overall noise exposures exceeded 90 dB(A) in 52% of research participants, which is more than the allowable limit advised by OSHA. Thus, it is evident that the noise pollution in and around urban areas of Chennai throughout the day is high.

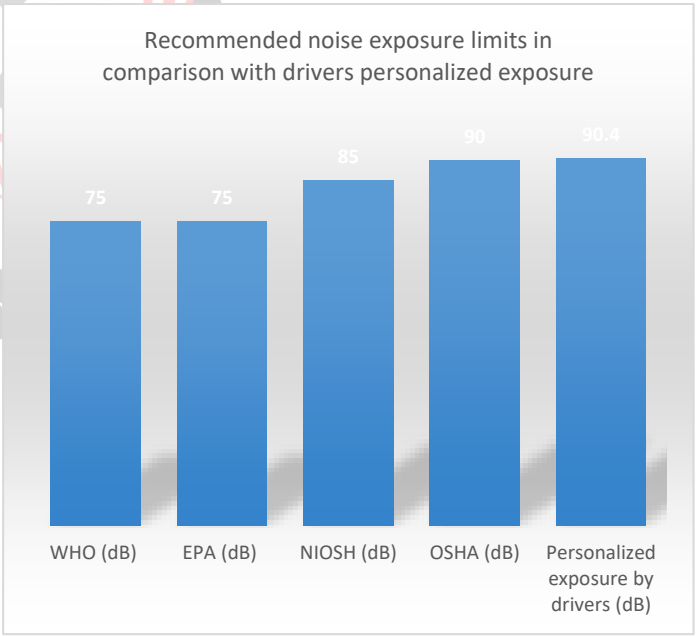

Figure 3: Differences in noise exposure measures in drivers compared to various standards (WHO, EPA, NIOSH and OSHA)

IV. DISCUSSION

The study's findings revealed comparable noise levels and noise dosage values during daytime. Both the average equivalent noise levels LAeq, (8h) (90.4 dBA) and the dose value (5.5% to 291.9 %) being significantly louder than the

 DOI : 10.35291/2454-9150.2023.0202

occupational exposure limits for noise established by various organization. Our findings from this study states that personalized noise exposure levels among drivers may pose a risk for noise-induced hearing loss. The findings were also compared with the permissible recommended limits of OSHA, NIOSH, EPA and WHO. According to the findings of this study, personalised noise exposure by drivers was shown to be higher than 90 dBA exposed for a complete work shift duration. The study finding along with the recommended limits indicated that if employees were exposed to noise levels beyond 90 dB(A) and continued to be exposed for many years, then the risk of hearing impairment among them may be expected much higher.

Sen et al. (2011) [11] assessed the noise exposure from operating auto rickshaws in the Indian metropolis of Kolkata. The study found that working in such environments where the noise dose surpassed 89 dB(A) is more unsafe and more likely to result in deafness owing to severe environmental pollution, that noise exposure and noise-induced hearing loss can affect the safety of drivers' daily lives. According to Karimi et al. (2010) [12], health monitoring programmes that emphasise education and routine medical examinations are important for pre-diagnosing and preventing of any possible impairment.

Proven methods for reducing noise exposures by Occupational Health and Safety suggest that noise dosimetry may be required if workplace noise levels vary throughout the day or if workers are mobile, driving vehicles or working in areas where it is either unsafe or impractical to use a sound level metre [13]. Majumder et al. (2009) [14] discovered noise levels in bus cabs ranging from 89 to 106 dB(A) and discovered that 89% of bus drivers had abnormal audiograms, indicating impaired hearing.

V. CONCLUSIONS AND RECOMMENDATIONS

This study investigated personalized noise exposure levels of auto-rickshaw drivers with the aim of quantifying the level of noise. The measurements of road traffic noise levels are higher than those set up by OSHA, NIOSH, EPA and WHO noise standards. Health risks to the auditory and non-aural systems are associated with prolonged exposure to high levels of traffic noise. To maintain hearing health, it is vital to enhance awareness and education about the negative consequences of excessive noise pollution among vehicle drivers who are subjected to constant noise. Research investigations are required to determine the exact prevalence of health impairment among auto-rickshaw drivers.

REFERENCES

[1] Dantewadia, Devulapalli & Padmanabhan, (2020, February 12). Which is India's noisiest city? Mint. https://www.livemint.com/news/india/which-is-india-s-noisiest-city-11581527059879.html

[2] Sun, (2023, March 31). Number of registered vehicles across India from financial year 1951 to 2019. Statista. https://www.statista.com/statistics/1023507/india-registered-vehicles-number/

[3] Sivasankaran, S. K., Rangam, H., & Balasubramanian, V. (2021). Investigation of factors contributing to injury severity in single vehicle motorcycle crashes in India. International journal of injury control and safety promotion, 28(2), 243-254.

[4] Sundaram, (2019, September 11) Auto makes a comeback in Chennai, 15,000 hit roads in one year. The times of India. https://timesofindia.indiatimes.com/city/chennai/auto-makes-a-comeback-in-chennai-15k-hit-roads-in-one-year/articleshow/71071777.cms

[5] Anil, H. T., & Arunima, S. (2020). Noise induced hearing loss in autorickshaw drivers in Bangalore: a cross sectional study. Indian Journal of Otolaryngology and Head & Neck Surgery, 1-7.

[6] Natarajan, N., Batts, S., & Stankovic, K. M. (2023). Noise-Induced Hearing Loss. Journal of Clinical Medicine, 12(6), 2347.

[7] John, L. M., Flin, R., & Mearns, K. (2006). Bus driver well-being review: 50 years of research. Transportation research part F: traffic psychology and behaviour, 9(2), 89-114.

[8] Chen, K. H., Su, S. B., & Chen, K. T. (2020). An overview of occupational noise-induced hearing loss among workers: epidemiology, pathogenesis, and preventive measures. Environmental Health and Preventive Medicine, 25, 1-10.

[9] Themann, C. L., & Masterson, E. A. (2019). Occupational noise exposure: A review of its effects, epidemiology, and impact with recommendations for reducing its burden. The Journal of the acoustical society of America, 146(5), 3879-3905.

[10] Moroe, N., & Mabaso, P. (2022). Quantifying traffic noise pollution levels: a cross-sectional survey in South Africa. Scientific Reports, 12(1), 3454.

[11] Sen, T., Bhattacharjee, P. K., & Banerjee, D. (2011). Effect of Noise Produced by Auto Drivers in India on Different Seasons. Assam University Journal of Science and Technology, 7(2), 44-51.

[12] Karimi, A., Nasiri, S., Kazerooni, F. K., & Oliaei, M. (2010). Noise induced hearing loss risk assessment in truck drivers. Noise and health, 12(46), 49.

[13] Tingay, J. (2016). Proven Methods for Reducing Noise Exposures. Occupational Health & Safety (Waco, Tex.), 85(10), 26-28.

[14] Majumder, J., Mehta, C. R., & Sen, D. (2009). Excess risk estimates of hearing impairment of Indian professional drivers. International Journal of Industrial Ergonomics, 39(1), 234-238.

 DOI : 10.35291/2454-9150.2023.0202