Noise Level inside Sri Lanka Transport Board Buses and Hearing Impairment of Long- and Short-Distance Bus Drivers of Ampara and Batticaloa Districts, Sri Lanka

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Abstract

Background: Transport drivers are more vulnerable to hearing impairment due to the traffic environment and fast-growing urbanization.
Objective: The study aims to determine the noise level inside the Sri Lanka Transport Board (SLTB) buses, hearing impairment of state transport bus drivers, and its associated factors in the selected districts of Eastern Province, Sri Lanka. Materials and Methods: A cross-sectional descriptive study was carried out among 256 state bus drivers using a systematic sampling technique. A screening tool to assess the level of hearing impairment of drivers and a format to measure equivalent noise level inside the SLTB buses were used to collect data. Noise measurement was done using Benetech Sound Level Meter (Model DB 130). Results: With reference to the noise level inside buses, 88.4% (n = 53) exceeded 85 dB (A), and 21.7% of buses (n = 13) were above 90 dB (A). According to the hearing tool’s hearing impairment assessment, the hearing of the majority of the study participants (84.4%, n = 216) was not affected. The association between hearing impairment and past history of ear diseases, surgeries, or head trauma was statistically significant (P = 0.017). Conclusions: Noise level inside the SLTB buses in Ampara and Batticaloa districts exceeded the 85 dB limit prescribed under the WHO standards of occupational noise exposure. The years of service of a bus was the only factor shown a statistically significant association with the level of noise inside the bus.

Keywords: Mass transit, noise dosimetry measurement, noise pollution, noise-induced hearing loss

Introduction

Noise is characterized by its intensity (loudness) which is measured in decibels (dB), and frequency (pitch) which is measured in Hertz (Hz).[1] In general, noise pollution is defined as regular exposure to elevated sound levels that may lead to adverse health effects in humans or other living organisms.

Hearing impairment or hearing loss occurs when you lose a part or all of your hearing ability. Hearing impairments are classified according to the severity of impairment and types. The severity of hearing impairment based on the minimum sound can be heard with your better ear; the higher the decibel, the louder the sound.[2] According to the WHO, above 5% of the world’s population (466 million people) suffer from disabling hearing loss, including 432 million adults and 34 million children.[3] “Disabling hearing loss refers to hearing loss >40 dB in the better hearing ear in adults and a hearing loss >30 dB in the better hearing ear in children.”[3]

Noise-induced hearing loss (NIHL) is the most prevalent irreversible industrial disease, leading to irreversible impairment to the auditory nerve and its sensory component.[4] Occupations that are more vulnerable to NIHL include manufactures, transportation, mining, construction, and military. In heavy motor vehicles, noise is usually experienced simultaneously with vibration. It is seen commonly for bus and lorry drivers who already share elevated stress levels from traffic environment and work.[4] It is stated in the literature that the risk of NIHL was more significant for drivers on the job,[5] and many suffer from hearing impairment.[6] Furthermore, the

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literature suggests the occurrence of hearing loss in the absence of complaints among transport drivers.[7] In the present study, we assessed the noise levels inside the Sri Lanka Transport Board (SLTB) buses in Ampara and Batticaloa districts and the state bus drivers’ hearing impairment level recruited from the same bus depots.

**Materials and Methods**

A descriptive cross-sectional study was carried out among 256 state bus drivers from Ampara and Batticaloa district depots using a systematic sampling technique from July to October 2018. The sample size was calculated using a standard formula.[9] All bus drivers, including long and short trip drivers who had completed a minimum of 3 years of service at the time of data collection, were included. Bus drivers with congenital hearing problems and documented current middle and inner ear diseases and injuries were excluded. A pretested interviewer-administered questionnaire, a screening tool to assess the level of hearing impairment of drivers, and a format to measure equivalent noise level inside the SLTB buses were used to collect data. The gold standard to measure hearing impairment is using pure-tone audiometry.[9] However, considering the limited time and resources, we have restricted measuring the hearing impairment using a screening tool with a self-assessment. A validated self-administered questionnaire (SAQ) adapted from Hearing Central USA[10] was used as a screening tool to assess the level of hearing impairment among public transport drivers. According to this screening tool, the grand score obtained from participants were categorized from no hearing impairment to severe impairment. The level was selected based on audiometric ISO value (in dB) for the impairment.[4,11]

Noise level measurements inside the bus cabin were taken using the Benetech Sound Level Meter (Model DB 130) using the standard procedure by a principal investigator (PI). The sound level meter was calibrated beforehand using acoustic calibrator B&K type 4230 by Industrial Technology Institute, Sri Lanka. Three measurements were taken for 3 min each in each bus. The noise was measured when buses are running at an average speed of 50–60 km/h between bus halts and at arm’s length of PI from the driver’s left ear. The 3-min equivalent sound pressure level (LAneq 3 min) was measured in the A-weighted network. Bus horn noise level was measured at 2 m from the front of the bus at engine level when the bus engine is on and geared in a neutral position through a single peep of the horn. The maximum noise pressure (LAmax) was obtained by using the same noise level meter. Ethical approval was obtained for the research from the Ethical Review Committee, Postgraduate Institute of Medicine, the University of Colombo, prior to the data collection (ERC/PGIM/2018/80).

**Results**

All the bus drivers recruited for the study responded to the survey. The response rate was 100% (n = 256). Although most participants stated that they have a good hearing, some revealed their difficulties in some situations [Table 1].

According to the screening tool, the grand score was calculated for each participant, and they were categorized from no hearing impairment to severe impairment. Hearing of the majority (84.4%, n = 216) of the study population was not affected. Mild hearing impairment was observed in 14.1% (n = 36) of the study population, while moderate hearing impairment was observed only in 1.6% (n = 4) of the study population [Table 2].

The mean age of drivers with hearing impairment was 44.63 years, with a standard deviation of 8.28. Table 3 shows the hearing impairment according to selected sociodemographic, work-related, leisure time activities and past history of ear diseases.

Noise measurement was done in randomly selected sixty buses from Batticaloa and Ampara district depots. According to the results, 66.7% (n = 40) of buses were between 85 dB (A) and 90 dB (A) levels. Nearly 21.7% of buses (n = 13) were above 90 dB (A). Only 11.6% (n = 7) of buses among the sample were well below 85 dB (A). The average noise level inside short-distance buses was slightly higher than long-distance buses (88.8 dB vs. 87.3 dB). It was found that there is a significant association between the noise level inside the bus and the years of service of a bus. In this study, above 90% of buses had exceeded 105 dB at 2-m distance from the front of the bus [Table 4].

**Discussion**

Based on findings by screening tool, hearing of the majority of the study population (84.4%) was not affected. Mild hearing impairment was observed in 14.1% of drivers, while moderate hearing impairment was observed in only 1.6% of the population. Similar low figures were reported by other studies, even with pure-tone audiometry (PTA).[7,12] In this study, it could be due to a large cutoff limit for severe hearing impairment. Even with the increased sensitivity (by combining the categories), it showed only 15.7% of the study populations with hearing affected.

The percentage of hearing impairment was high in married participants compared to unmarried. The majority of participants (86.8%) who come to the workplace by nonmotorized means had normal hearing. Further, only 16.2% of participants using motorized means to come to work had hearing loss, which was slightly higher than nonmotorized means. The results were similar to the study by Hapuarachchi et al.[13] Although we did not find a statistically significant difference between work distance/shifts, music while driving, and hearing impairment, studies by Lopes et al.,[7] Karimi et al.,[12] and Aslam et al.[10] report a significant association between these variables with hearing impairment. Further, this difference may be due to different methods of assessing the hearing impairment between the present study and the above studies.
The present study found that noise level inside the SLTB buses in the Eastern Province varied between 72.1 and 106.5 dB (A) with a mean of 87.9 dB, and only about 21.7% of buses (n = 13) had exceeded noise level above 90 dB. A survey done in the Colombo district by Hapuarachchi et al. among inter-provincial buses revealed that the majority of buses’ noise level ranged between 85 and 90 dB, and about 11% of buses exceeded the above 90 dB. A similar study by Mondal et al. in West Bengal found that the noise level inside the buses’ cabin was in the range of 88.6–102.4 dB. Therefore, this study and similar studies indicate that the noise level inside the buses is well above the recommended standards.

A study by Nadri et al. conducted among 80 public transport bus drivers in an urban city of Iran have found no statistically significant association between the age of the bus or route and the noise level inside the buses. In the present study, it was found that there is a significant association between the noise level inside the bus and the years of service of a bus. The noise level inside the buses with the sound system “On” condition varied between 72.1 dB and 106.5 dB while it varied between 75.8 dB and 104.8 dB with the sound system “Off” condition. Although it was not measured in the same buses, this study concludes that music is not an issue in state buses as most buses were not equipped with music systems. Further, in the installed buses, the drivers mentioned that they are not playing it very loud. When considering noise discharge from the air horn, the present study indicates the noise level at 2 m from the front of a bus varying in between 103.1 dB and 118.2 dB with a mean of 109.8 dB. In this study, above 90% of buses had exceeded 105 dB at 2-m distance from the front of the bus, which was found similar to Hapuarachchi et al. study. Overall, this study shows that drivers are exposed to the ambient amount of noise due to their working conditions regardless of the type of bus, route, and absence of music on board.

Measuring hearing impairment was restricted to a screening tool with a self-assessment due to the limited resources and feasibility, even though the gold standard to measure hearing impairment is PTA. There was no specific screening tool to assess hearing impairment among drivers. Therefore, after a detailed literature review, a SAQ was adapted from Hearing Central USA and used as a screening tool to assess the level of hearing impairment in the current study setting. A senior lecturer and a senior consultant ENT surgeon from Teaching Hospital Batticaloa reviewed the questionnaire’s content validity. Nevertheless, there may have been significant underdetection by selecting this screening tool when compared with PTA.

Furthermore, some participants may have provided answers to screening tools regarding real-life hearing situations that were inaccurate (and even though PI convinced them about the importance and objectives of the study through a short introduction prior to data collection). It may be due to a lack of knowledge on the importance of such a study and some who did not want to reveal their hearing condition while they are in the service. Furthermore, recall bias may have affected some participants.

### Table 1: Frequency distribution of drivers according to the answers provided for hearing assessment screening tool

| Statement | Always, n (%) | Sometimes, n (%) | Never, n (%) |
|-----------|---------------|-----------------|-------------|
| High tone questions | | | |
| I can hear the ticking of the clock when I’m at home | 197 (77.0) | 55 (21.5) | 4 (1.6) |
| I can hear the phone ring when I’m at home | 247 (96.5) | 9 (3.5) | 0 |
| Social situation questions | | | |
| I ask people to speak up or repeat themselves | 184 (71.9) | 68 (26.6) | 4 (1.6) |
| I have trouble hearing people when they speak softly | 193 (75.4) | 59 (23.0) | 4 (1.6) |
| I miss some words and sentences in a phone conversation | 184 (71.9) | 70 (27.3) | 2 (0.8) |
| I cannot hear too well in church/temple | 201 (78.5) | 51 (19.9) | 4 (1.6) |
| I have difficulty in understanding conversation while on the bus with my conductor | 201 (78.5) | 53 (20.7) | 2 (0.8) |
| Family situation questions | | | |
| Family members complain that I have the radio/TV up too loud | 218 (85.2) | 34 (13.3) | 4 (1.6) |
| Family members accuse me of not paying attention while they talk with me | 225 (87.9) | 31 (12.1) | 0 (0) |
| Family members sometimes ignore me when they have a conversation | 242 (94.5) | 14 (5.5) | 0 (0) |
| Personal attitude questions | | | |
| At a meeting or get together I’m reluctant to participate because I have missed part of the discussion | 237 (92.6) | 18 (7.0) | 1 (0.4) |
| I feel frustrated and lose patience with loved ones after my shift | 194 (75.8) | 56 (21.9) | 6 (2.3) |
| I’m spending more and more time alone when I’m at home because it’s just too hard to communicate with my family members | 242 (94.5) | 14 (5.5) | 0 (0) |

### Table 2: Frequency distribution of participants with hearing impairment as detected by the screening tool

| Level of hearing impairment | n (%) | 95% CI |
|----------------------------|-------|-------|
| No impairment              | 216 (84.4) | 79.9-88.9 |
| Mild impairment            | 36 (14.1) | 9.8-18.4 |
| Moderate impairment        | 4 (1.6) | 0.1-3.1 |
| Severe impairment          | 0 | 0 |

CI: Confidence interval
| Characteristics                              | Impaired hearing, n (%) | No hearing impairment, n (%) | Total, n (%) | P    |
|---------------------------------------------|-------------------------|------------------------------|--------------|------|
| Ampara                                      | 18 (13.1)               | 119 (86.9)                   | 137 (100.0)  | 0.301|
| Batticaloa                                  | 22 (18.5)               | 97 (81.5)                    | 119 (100.0)  |      |
| Marital status                              |                         |                              |              |      |
| Married                                     | 39 (16.2)               | 201 (83.8)                   | 240 (100.0)  | 0.480|
| Unmarried                                   | 1 (6.2)                 | 15 (93.8)                    | 16 (100.0)   |      |
| Mode of transport to work                   |                         |                              |              |      |
| Nonmotorized means                          | 7 (13.2)                | 46 (86.8)                    | 53 (100.0)   | 0.675|
| Motorized means                             | 33 (16.2)               | 170 (83.7)                   | 203 (100.0)  |      |
| By type of route                            |                         |                              |              |      |
| Long distance                               | 19 (15.6)               | 103 (84.4)                   | 122 (100.0)  | 1.000|
| Short distance                              | 21 (15.7)               | 113 (84.3)                   | 134 (100.0)  |      |
| Average number of days working per week     |                         |                              |              |      |
| 6                                           | 14 (15.4)               | 77 (84.6)                    | 91 (100.0)   | 1.000|
| 7                                           | 26 (15.8)               | 139 (84.2)                   | 165 (100.0)  |      |
| Average numbers of hours of driving per day |                         |                              |              |      |
| 9 h and less                                | 13 (15.5)               | 71 (84.5)                    | 84 (100.0)   | 1.000|
| Above 9 h                                   | 27 (15.7)               | 145 (84.3)                   | 172          |      |
| Putting music while driving                 |                         |                              |              |      |
| Yes                                         | 22 (13.8)               | 138 (86.2)                   | 160 (100.0)  | 0.292|
| No                                          | 18 (18.8)               | 78 (81.2)                    | 96 (100.0)   |      |
| Any previous job before joining SLTB?        |                         |                              |              |      |
| Yes                                         | 30 (14.3)               | 180 (85.7)                   | 210 (100.0)  | 0.260|
| No                                          | 10 (21.7)               | 36 (78.3)                    | 46 (100.0)   |      |
| Routinely listen to music                   |                         |                              |              |      |
| Yes                                         | 20 (12.9)               | 135 (87.1)                   | 155 (100.0)  | 0.159|
| No                                          | 20 (19.8)               | 81 (80.2)                    | 101 (100.0)  |      |
| Level of volume while listening to music or watching TV | | | | |
| More than half level of volume              | 5 (29.4)                | 12 (70.6)                    | 17 (100.0)   | 0.156|
| Half or less than half level of volume      | 35 (14.6)               | 204 (85.4)                   | 239 (100.0)  |      |
| Past history of ear disease or surgery or head trauma | | | | |
| Yes                                         | 6 (40.0)                | 9 (60.0)                     | 15 (100.0)   | 0.017|
| No                                          | 34 (14.1)               | 207 (85.9)                   | 241 (100.0)  |      |

SLTB: Sri Lanka Transport Board

| Characteristics                              | Number of buses, n (%) | L\text{A}_{eq} min | L\text{A}_{eq} maximum | L\text{A}_{eq} average | P    |
|---------------------------------------------|------------------------|--------------------|------------------------|------------------------|------|
| Type of bus                                 |                         |                    |                        |                        |      |
| Ashok Leyland                               | 52 (86.7)              | 72.1               | 106.5                  | 87.9                   | 0.065|
| Tata                                        | 8 (13.3)               | 76.6               | 104.1                  | 91.3                   |      |
| Type of trip                                |                         |                    |                        |                        |      |
| Long distance                               | 18 (30.0)              | 72.1               | 106.5                  | 87.3                   | 0.052|
| Short distance                              | 42 (70.0)              | 75.6               | 104.8                  | 88.8                   |      |
| Years of service                            |                         |                    |                        |                        |      |
| <4                                          | 9 (15.0)               | 72.1               | 106.5                  | 87.0                   | 0.00001|
| 4-6                                         | 24 (40.0)              | 74.4               | 99.3                   | 87.1                   |      |
| 7-8                                         | 25 (41.7)              | 75.8               | 101.3                  | 89.3                   |      |
| >8                                          | 2 (3.3)                | 88.7               | 104.8                  | 97.4                   |      |
| Music onboard                               |                         |                    |                        |                        |      |
| On                                          | 14 (23.3)              | 72.1               | 106.5                  | 86.9                   | 0.033|
| Off                                         | 46 (76.7)              | 75.8               | 104.8                  | 88.8                   |      |

L\text{A}_{eq}: Equivalent sound pressure level
Conclusions

Despite the high noise level found inside the buses, the frequency of hearing impairment detected by the screening tool was less. Based on the findings of the screening tool, the hearing was affected only 15.7%. There were no statistically significant associations found between hearing impairment and work station, marital status, mode of transport to work, route type, working hours, service experience, playing music on board, or participant’s leisure time music listening habits even though there was a slight rise in the hearing impairment among these comparison groups.

Recommendations

Attempts should be taken by the environmental regulatory authorities, SLTB, depot management, engineering services, and bus drivers to lower the noise level emanating from the engine compartment. The engineering services division of SLTB should take necessary steps to enforce proper engineering control methods to reduce the noise emission from the engine compartment, such as enclosing the engine compartment with soundproof materials and tightly sealing it off rather than using a plastic cover. The bus drivers should undergo regular audiometry examination to identify hearing impairment prevalence with a PTA.

Further, all public transport bus drivers should undergo a hearing assessment at the time of recruitment and periodic assessment for hearing and other diseases. It should be strengthened by local health authorities and tertiary health-care institutions coordinated by the labor department. Depot managers and in-charge officers should explore the feasibility of reducing the number of hours spent on roads (to reduce the noise exposure) by bus drivers. The reduction of the number of hours spent can be achieved by increasing the pool of drivers or reducing the number of hours per shift (which is more feasible with short-distance bus drivers). Strict enforcement of the law is necessary against the bus drivers who use powerful air horns not abiding by horn regulations prescribed under the National Environmental Act.

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Conflicts of interest

There are no conflicts of interest.

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