

Association of Hearing Health with Traffic Accidents among Heavy Vehicle Drivers

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Abstract

Aim: Excessive exposure of drivers to traffic noise and the resulting hearing loss could affect safe driving. This study aimed to investigate the hearing status of heavy vehicle drivers and its correlation with traffic accidents. **Materials and Methods:** This cross-sectional study was conducted on 187 drivers of heavy vehicles (trucks and buses) in Tehran province during 2018. The hearing status of drivers was investigated by the audiometric test method, ISO 6189 (1983). A safety questionnaire and checklist of drivers' demographic variables were used to gather information on accident status and personal characteristics of drivers. SPSS version 24 software was used for the statistical analysis of data. The statistical tests used are Chi-square, Spearman's correlation, paired *t*-test, and odds ratio. **Results:** Examining the hearing status of drivers showed that 51.5% were normal and 48.5% of drivers had hearing loss. The highest mean hearing threshold was at a frequency of 4000 Hz. The mean (standard deviation) for the right and left ears was 27.82 ± 15.92 and 18 ± 27.32 dB, respectively. The results of the analysis on drivers' hearing status and accidents showed a significant correlation between the frequency of accidents and the classification of drivers' hearing loss. Thus, a significant relationship with the correlation coefficient of 0.123 and 0.307, respectively, was obtained between the average hearing loss of drivers and having one or five accidents. **Conclusion:** The findings of the study showed hearing loss in drivers in the left ear, especially at high frequencies. There is also a significant relationship between the number of accidents and the rate of hearing loss of drivers. Hearing loss caused by noise interferes with activities such as driving and negatively affects the safety of drivers and emphasizes the importance of preventing accidents by controlling traffic noise.

Keywords: Driver safety, hearing loss, traffic accident

INTRODUCTION

Road traffic accidents are the second-leading cause of death after coronary heart disease, and their costs in low- and middle-income countries, such as Iran, are estimated between 1% and 2% of the gross domestic product. Besides, the rate of road traffic accidents in Iran is significantly increased in recent years.^[1,2] Since the high rate of traffic accident deaths and injuries is largely avoidable, it is necessary to recognize the factors and conditions of these accidents and take appropriate measures for eliminating them.^[1] Several factors are involved in the occurrence of these accidents, including human factors, road factors, and vehicle factors.^[3] Meanwhile, human factors known as unsafe actions and driver errors are the most frequent cases of accidents.^[3] Drivers are at increased risk of health problems caused by their jobs and this will get worse over long years of activity. The most important health problems for drivers are occupational hearing loss and traffic noise-induced

disorders.^[3] Noise can damage the hearing system and intensify several psychological disorders that increase the stress imposed on people.^[4]

In recent years, road traffic has played a significant role in causing background noise, which could adversely affect the communities.^[5] Traffic noise is considered a major source of environmental pollution in developed and developing countries with psychosocial and physiological effects on people.^[6] Professional drivers are exposed to high levels of noise for long periods.^[6] Since noise is often experienced simultaneously

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with vibration, these two harmful factors are more prevalent in professional drivers. This is concerning in particular for bus and truck drivers who have experienced the environmental pressures of traffic and time pressures at work.^[4] For such drivers, working conditions have gotten worse in recent years. This is largely due to traffic congestion and corresponding noise pollution.^[4]

There are several reports of hearing loss in noisy environments, indicating that background noise is considered an occupational detrimental factor for professional drivers.^[7] Numerous studies have been conducted on the negative effects of noise on professional drivers; Merchant *et al.* reported hearing loss and tinnitus on the drivers of the city of Karachi using the Smith Hearing Screening Questionnaire.^[8] Ali and Tamura investigated the road traffic noise in 21 areas of Cairo (Egypt). They observed a relationship between the levels of road traffic noise and hearing impairment.^[9] Mukherjee *et al.* (2009) studied the exposure to equivalent noise of public transport bus service in Calcutta, India. They found that exposure to high noise levels depends on the number of travels per day and exceeded the suggested standard.^[10]

Majumder *et al.* in a study on the level of hearing impairment in Calcutta, India, found that occupational noise in professional drivers considerably increases their hearing threshold compared to office workers. In India, another study showed that the noise level in bus cabins is about 89–106 dB (A) and it is found that 89% of bus drivers had hearing impairment.^[11]

According to research, hearing loss usually occurs due to excessive continuous exposure to noise above 85 dB (A) for several years.^[12] The results of some laboratory studies indicate that disorders induced by loud noise could persist after exposure time.^[13] One of the recent studies on 2000 drivers showed that noise exposure increased the risk of road accidents.^[14] The findings of Golmohammadi *et al.* (2015) also showed that the rate of unsafe actions performed by drivers was 42.71% and their sound exposure is in the high-risk range. With increasing noise exposure and occupational stress level of drivers, the rate of unsafe actions and probable occurrence of accidents is increased.^[15]

Summarizing the findings of the studies and paying attention to the fact that safe driving requires the capability of receiving environmental messages through the various senses, including hearing, interpretation, and accommodation, hearing will affect the major communications of the driver. For instance, the driver should be able to hear the sound of a vehicle approaching from behind. If the driver could hear the noises of engine failure or other parts of the car, he could prevent the damages and important consequences such as an accident with early detection of potential faults. There is scattered information on the hearing status of drivers in Iran and worldwide.^[16] Some studies have also been conducted on traffic noise, most of which have investigated the effects of this type of noise on the community; however, there are few studies on the effects of noise on safe driving and traffic accidents.^[17] Therefore,

further studies in this field are highly important, given the frequent exposure of drivers to traffic noise and the secondary effects of hearing loss on driving safety. In this regard, this study was conducted to investigate the hearing status of drivers of heavy vehicles (trucks and buses) and its association with traffic accidents.

MATERIALS AND METHODS

This cross-sectional study was carried out on the drivers of heavy vehicles in Tehran province. The participants in the study of the two-stage cluster random sampling method were selected from several occupational medicine centers. First, out of 14 centers, six occupational medicine centers were randomly selected as clusters. In the next stage, 40 drivers in each cluster were randomly selected for the samples. Thus, a total of 240 drivers were included in the study.

Inclusion criteria were male drivers with at least a 2-year valid driver's license and complete personal information and medical records of drivers. Inclusion in the study was entirely voluntary and participants were excluded if they were not willing to continue their participation. Considering inclusion and exclusion criteria, 53 people were excluded from the study. The final study population included 187 heavy vehicle drivers who were selected. Completeness of information, especially demographic characteristics and audiometry results of drivers in their files, was one of the most important criteria in this manuscript.

In the present study, a demographic checklist (including age, height, weight, working hours per 24 h, rest hours during the day, and smoking) and safety questions including accidents and near miss prepared by researchers were used to extract information. Accidents have been considered, which lead to accidents with pedestrians, accidents with cars, collisions with obstacles, and overturning. Those who were qualified during the in-person interview were first instructed on how to fill in the questionnaire and then the questionnaire was given to them. Informed consent was also received from all participants and the confidentiality of their information was assured.

Then, the audiometry test was carried out by an audiologist following the methods specified in ISO 6189 (1983). In this method, the hearing threshold of people was measured separately by pure-tone audiometry at frequencies of 500, 1000, 2000, 3000, 4000, 6000, and 8000 Hz for the left and right ears. The results of this test were anonymous for ethical considerations and confidentiality of information. With hearing threshold in various frequencies for both ears, the total hearing loss of an individual was determined and classified by Table 1.^[18]

Data were analyzed using descriptive and inferential statistics. Descriptive statistics were used to study the frequency distribution and central tendency indices of research variables. Inferential statistics were also used to investigate the impact of hearing loss variables on accidents. In this regard, Chi-square, Spearman's correlation, odds ratio, and paired *t*-test were used.

The natural distribution of research data was also analyzed by the Kolmogorov–Smirnov test. The significance level for all tests was 0.05. Data were analyzed using SPSS version 24 (IBM SPSS Inc., Chicago, IL, USA).

Ethical clearance

Ethical approval for this study (IR.TUMS.MEDICINE.REC.1397.491) was provided by the Ethical Committee Tehran University of Medical Sciences, Tehran, on 06 October 2018.

RESULTS

This cross-sectional study is carried out on the drivers of heavy vehicles in Tehran province during 2018. In this study, 185 drivers of heavy vehicles participated. The mean and standard deviation (SD) of age, height, and weight of the studied drivers were 47.5 ± 9 years, 173 ± 6.6 cm, and 87.3 ± 11.7 kg, respectively. The mean and SD of drivers’ working hours per 24 h were 10.66 ± 2.52; and rest hours during the day were 8.7 ± 1.12 h, respectively. Furthermore, 67.5% of the drivers studied were smokers.

The status hearing of the studied drivers showed that 51.5% of them had normal conditions and 48.5% of the drivers were associated with some degree of hearing loss in both ears. Furthermore, 78% of drivers reported hearing the sound of the vehicle while resting and sleeping.

Results of hearing threshold analysis at each central frequency (500–8000 Hz), mean, SD, and maximum and minimum hearing loss for both ears are shown in Table 2. The mean SD of the hearing threshold at the frequency of 4000 Hz for both left and right ears was at maximum of 27.82 ± 18 and 25.32 ± 15.92 dB, respectively. There is no significant difference between the two ears at 500 and 1000 frequencies, and there is a significant difference at other frequencies.

The total hearing loss status of drivers was classified into five groups (normal, slight hearing loss, mild hearing loss, moderate hearing loss, and severe hearing loss). The number and percent of each of the drivers’ hearing status groups are given in Table 3. Three drivers had the highest frequency of accidents (six cases), all of whom were in the group of severe hearing loss.

To study the relationship between the number of accidents and hearing loss status of drivers, the Spearman’s correlation and odds ratio were used as presented in Table 4. In drivers with severe hearing loss, the odds ratio of having four, five, and six accidents are 5.923, 4.854, and 17.108, respectively, times as other drivers. There was a significant relationship between the results of severe hearing loss and having five and six accidents, and the correlation rate was 0.218 and 0.468, respectively.

The relationship between the number of drivers’ accidents in different groups with hearing loss status (normal, slight, mild, moderate, and severe) was examined by the Chi-square test.

Table 1: Hearing status classification based on hearing loss threshold

Hearing status classification	dB
Normal	0-15
Slight loss	16-25
Mild loss	26-40
Moderate loss	41-50
Severe loss	≥51

Table 2: Mean, standard deviation, and minimum and maximum hearing threshold in the left and right ears at the different frequencies (185 participants)

Frequency	Mean ± SD	Minimum	Maximum	P (paired t-test)
500				
Right	18.22±14.32	0	65.00	0.344
Left	18.65±15.94	0	75.00	
1000				
Right	18.00±16.45	0	75.00	0.285
Left	18.45±15.06	0	65.00	
2000				
Right	18.92±16.66	0	70.00	<0.001
Left	21.00±16.63	0	70.00	
3000				
Right	24.40±16.44	0	80.00	<0.001
Left	25.75±16.06	0	70.00	
4000				
Right	25.32±15.92	0	65.00	<0.0001
Left	27.82±18.00	0	70.00	
6000				
Right	23.07±17.00	5.00	65.00	<0.001
Left	24.90±18.72	5.00	70.00	
8000				
Right	21.22±19.21	5.00	80.00	<0.001
Left	22.80±19.77	5.00	80.00	

SD: Standard deviation

The Chi-square test and degrees of freedom were 113.485 and 24, respectively, and a significant relationship was found between the number of accidents and the hearing loss status of drivers (*P* < 0.001).

DISCUSSION

Heavy vehicles, as a source of background and occupational noise, could affect the hearing health of drivers and consequently the occurrence of accidents.^[19] As many studies have confirmed, excessive and permanent noise can damage the hearing system among heavy vehicle drivers.^[20] The findings of the present research showed that the rate of hearing loss at moderate frequencies (3000–8000 Hz) is higher than at other frequencies, so a considerable difference is seen in hearing loss at a frequency of 4000 Hz. According to the results of this study, hearing loss in professional drivers was more common in the left ear than in the right ear. In the

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Table 3: The number and percent of accidents in each of the drivers' hearing status

Hearing status	Number of accidents						
	None, n (%)	1, n (%)	2, n (%)	3, n (%)	4, n (%)	5, n (%)	6, n (%)
Normal	23 (59)	69 (59)	3 (37.5)	1 (11.1)	-	-	-
Slight	14 (35.8)	30 (25.6)	5 (62.5)	4 (44.4)	-	-	-
Mild	2 (5.2)	9 (7.7)	-	1 (11.1)	2 (50)	-	-
Moderate	-	6 (5.1)	-	2 (22.2)	-	3 (60)	-
Severe	-	3 (2.6)	-	1 (11.1)	2 (50)	2 (40)	3 (100)
Total (n)	41	117	8	9	4	5	3

Table 4: The odds ratio and correlation (Spearman's) of the number of accidents with driver's hearing status

Hearing status	Number of accidents					
	1	2	3	4	5	6
Slight						
Odds ratio	0.007	5.025	1.688	2.32	2.919	1.741
P	0.934	0.12	0.17	0.246	0.193	0.316
Mild						
Odds ratio	0.564	1.098	0.278	1.418	0.681	0.406
P	0.462	0.449	0.568	0.131	0.553	0.647
Moderate						
Odds ratio	3.419	1.36	1.85	2.674	9.255	2.504
P	0.022	0.197	0.011	0.554	<0.001	0.061
Severe						
Odds ratio	7.64	2.098	1.978	5.923	4.854	17.108
P	0.005	0.044	0.068	<0.001	0.002	<0.001

present study, which is conducted on bus and truck drivers, audiometric results indicated that 51.5% of the drivers were in normal condition and 48.5% of whom had a degree of hearing loss. Karimi *et al.* also showed that the effect of noise depends on frequency and hearing loss occurred at frequencies 4000 and 8000 earlier than other frequencies and 12.6% of truck drivers had hearing impairment in the left ear.^[20] In another study on 1000 professional drivers, almost 52% had slight hearing loss and there was a significant relationship between age, work experience, and hearing loss.^[21] In some studies conducted on truck and bus drivers, the relationship between age and hearing loss is significant, which can also be due to their work experience.^[22] In the present study, hearing loss in drivers was considerably higher in the left ear. This could be due to exposure of drivers' left ear to the side window and more noises, indicating one-way left ear contact with the noise. Other studies confirm further hearing loss in the left ear.^[23] According to Table 2, there was a greater difference between the hearing thresholds of two ears at higher frequencies. This is due to abnormal traffic noises or loud horns of other vehicles. Other studies suggest that when a person receives more noise from one ear than the other, the hearing threshold in both ears indicates an asymmetry, which is more common in truck or tractor drivers as well as firearms users so that it causes hearing loss in the ear close to the engine exhaust among truck or tractor drivers and the ear close to the trigger among firearms users.^[24]

In Table 3, the number of accidents in each of the drivers' hearing conditions is presented. Increased hearing loss is associated with an increase in the number of accidents; Moderate-to-severe hearing loss is seen in drivers with more accidents. The findings presented in Table 4 indicate a significant relationship between the frequency of accidents and moderate-to-severe hearing loss of drivers in high rate of accidents and show the correlation between the results of these variables. The results of Table 4 also show that accident risk (odds ratio) with hearing loss is increased for high rate of accidents.

As reported, the odds ratio for six accidents over 5 years with severe hearing loss is increased by 17.1; which applies to four and five accidents. Findings obtained from the Chi-square test show that there is a significant relationship between the number of accidents and the hearing loss status of drivers ($P < 0.05$). In this regard, the results of Girard *et al.*^[25] and Picard *et al.*^[26] verify the relationship between exposure to occupational noise and the resulting hearing loss with the risk of accidents (increased odds ratio) at work. The findings of these studies support this hypothesis using the data derived from about 240,000 people that independent variables investigated (exposure to noise and hearing impairment) affect occupational safety and are related to industrial accidents. According to Barreto *et al.*,^[27] a detailed review of the effective factors in this field shows the greater effect of noise-induced hearing loss on driving safety, and it increases the risk of motor vehicle accidents by 5.6 times due to further exposure to occupational noise. Findings demonstrate that hearing impairment could restrain drivers from receiving corresponding auditory signals (such as input vehicle noise, or audible alarms). These results are following reports of Roberts and Norton,^[28] where the rate of accidents in the case of moderate hearing loss is almost doubled. According to Morata *et al.*,^[29] excessive exposure to occupational noise increases the risk of traffic accidents in a small number of people. This is attributed to their lower potential in evaluating audible traffic alerts and audible alarm signals in the vehicle. In contrast to the results of this study, Jahangiri *et al.*^[30] did not report any considerable changes in the hearing threshold of drivers. Moreover, no significant relationship was seen between road accidents and the hearing ability of drivers, but the hearing status was weaker among drivers who have experienced road accidents.

Given the sensitive nature of driving and the significance of the sense of hearing, the relationship of drivers with outside could not be disconnected. Besides, drivers must be protected from the adverse health effects of noise; therefore, the use of personal protective equipment would not also be an appropriate strategy.^[26] The possible conservation methods for drivers include periodic audiometry testing, reduced working hours of drivers, enforcement of regulations, and standardization of noise levels in vehicle engines. It is also suggested to use a silencer between the driver's cab and engine. Compliance with the aforementioned guidelines not only reduces hearing loss in professional drivers but also dramatically reduces noise pollution.

The limitations of this study are the lack of access to preliminary audiometry results of drivers. Interpretation of these results distinguishes the contribution of the effect of traffic noise on hearing loss from other factors. It is suggested that this issue be considered in future studies.

CONCLUSION

Findings obtained from drivers' hearing status showed that 51.5% had normal condition and 48.5% of drivers had hearing loss. The hearing threshold at 4000 Hz had the highest average. Examination of the results of drivers' hearing status and accidents showed a significant relationship between the number of accidents and drivers' hearing loss status.

The findings of the study show that noise-induced hearing loss interferes with activities such as driving and negatively affects the safety of drivers and leads to adverse consequences such as traffic accidents. These consequences are more noticeable among those with noise-induced hearing loss. Considering the number of young adults and their role as professional bus and truck drivers in road and traffic safety, further research is required to determine the effect of hearing loss and exposure to noise on the safe performance of heavy vehicle drivers. These findings of exposure to traffic noise and hearing loss emphasize the importance of paying attention to accident prevention with reducing traffic noise. Thus, some measures should be taken, by the automotive industry to reduce vehicle noise; including introducing advanced automotive technology such as engine noise silencer and vehicle noise proofing.

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Conflicts of interest

There are no conflicts of interest.

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