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Association of Road Traffic Noise Exposure and Driving Behaviors

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Background: The noise caused by traffic is an increasingly prominent feature of urban environments. However, limited studies have been focused on the assessment of exposure-response relationship between road traffic noise exposure and driving behaviors in Iran. The present study aimed to investigate the prevalence of the violations caused by road traffic noise exposure in Qazvin, Iran.
Methods: Initially, a line with 70 taxi drivers was selected for the evaluation of noise exposure. According to ISO9612:2009, the eight-hour equivalent noise level [Leq8h] was measured during a workday. In addition, driving behaviors were assessed using the self-report Iranian version of Manchester driving behavior questionnaire (MDBQ).
Results: Statistical analysis included the mean, standard deviation, minimum and maximum, Pearson's correlation-coefficient, and logistic regression. The results of Pearson's correlation-coefficient indicated a strong correlation with noise levels and personal characteristics with driving behaviors ($P < 0.05$). Moreover, logistic regression showed that noise level was significantly associated with the components of driving behaviors.
Conclusion: According to the results, traffic noise exposure is a significant influential factor in the increased rate of driving violations. Equivalent sound pressure level in taxies was observed to be above of the limit for occupational comfort based on NR 17 standard, which may affect driving behaviors.

1. Introduction

Road traffic causes significant pollution in urban areas, adversely affecting human health. Among the negative health impacts of traffic, noise pollution has been emphasized by numerous researchers [1, 2]. Noise pollution is defined as unfavorable noise caused by human activity. Noise directly influences human health, leading to hearing damage and higher risk of cardiovascular diseases, stroke, heart attack, and diabetes, as well as stress reactions [3-5].

The adverse health effects of environmental noise is a growing concern across the world [6]. According to the recent evaluations performed by the European Economic Area (EEA), road traffic is the largest source of noise pollution [7, 8]. Almost 90% of the health effects caused by noise exposure are also associated with road traffic noise. In addition, the Environmental Protection Agency has estimated that at least 10,000 premature deaths occur each year due to traffic noise exposure [9]. Due to these adverse health effects, noise pollution is considered to be a major stressor in terms of the environmental burden of diseases [10].

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Previous studies regarding the adverse effects of noise on humans have proposed contradictory results. Nonetheless, noise pollution is known to affect performance on different levels. However, Kryter (2013) has claimed that intense noise has no effect on performance, and nearly all industrial and laboratory experiments reporting that noise pollution adversely affects the work output of individuals are open to criticism due to poor experimentation and the presence of uncontrolled factors. The experiments that have been carried out with the proper control of all the pertinent factors reveal that steady or expected noises have no adverse effects on the psychomotor activity to any significant extent [11].

Unlike Kryter, studies showed concluded that there is sufficient evidence to confirm that the work output and speed are affected by noise pollution. Moreover, several studies stated that performance defects are more likely caused by exposure to high-intensity, intermittent noise, rather than exposure to low-intensity or steady noise pollution. In this regard, the other findings represented an initial decline in tracking the performance of the individuals exposed to intermittent auditory motivation, followed by the gradual improvement of the performance concomitant to noise adaptation. It is also notable that in recent years, few studies have investigated the behavioral effects of noise pollution. Eventually, the current findings imply that noise pollution could cause minimal or transient behavioral changes with time [12, 13].

Road traffic injuries are among the leading causes of incapacitation and mortality across the world [14]. Most of the hospitalizations in the emergency department are due to traffic injuries, which are associated with substantial financial burdens directly and indirectly, constituting a major portion of the annual budget in every country [15]. According to reports, two million people die in various regions of the world due to traffic accidents, and 50 million people are also injured [16]. Driving behaviors are considered to be the main cause of traffic accidents [17]. The mistakes and violations of drivers play a pivotal role in the occurrence of road accidents [18]. Therefore, controlling the impact of human factors could reduce the incidence of driving violations and road accidents [19].

Considering the lack of studies regarding the correlation between transportation noise and driving behaviors in taxi drivers in Iran, as well as the growing number of the drivers exposed to traffic noise is Qazvin, Iran, the present study aimed to assess the effect of traffic noise on driving behaviors and the association of these variables using quantitative and qualitative methods [20].

2. Materials and Methods

2.1. Selection of the Routes

In the initial phase of the current research, noisy routes were selected to assess the level of noise pollution [20]. Based on the data provided by the management department of taxi drivers, one noisy route consisting of seven streets was selected for evaluation. In the selected route, the traffic noise was measured twice.

2.2. Participants

Sample population included all the taxi drivers frequenting in the selected route. The inclusion criteria were as follows: 1) willingness to participate in the study; 2) absence of psychotherapy, drug addiction, and alcohol consumption; 3) having a valid Iranian driver's license; 4) a minimum of 40 hours of driving per week as a job and 5) a minimum of one year of driving experience. The exclusion criteria were the presence of ear infections or hearing loss unrelated to traffic and unwillingness to continue participation. The final samples size was determined to be 70 married, male drivers.

2.3. Assessment of the Level of Noise Exposure

After selecting the routes and participants, the proposed measurement strategies were applied for the assessment of noise exposure. In accordance with ISO9612:2009, selecting the most appropriate method, which is known as the recommended strategy in the standard, to measure noise exposure depends on specific features of jobs, including the type of work and work patterns (e.g., mobility of workers and complexity of tasks.

The recommended strategies in ISO9612:2009 have been presented in three categories of task-based measurement (TBM), job-based measurement (JBM), and full-day measurement (FDM). This standard proposes that only one strategy should be selected for each type of workplace. As suggested by ISO9612:2009, if the differences between the three primary measurements were more than 3dB(A), FDM was carried out [21, 22].

Dosimetry is the most reliable method for the measurement of noise exposure. There is a short-term strategy for the cases in which the noise exposure in workers has a specific pattern. In this strategy, the dosimeter is used within a short period (minimum: 15 minutes) for each exposure time [22]. In the present study, four-hour short-term dosimetry was performed in the morning (8-10 AM) and evening shifts (16-18 PM). The measurements were carried out using the CASELLA CEL SONUS (GA 257) dosimeter, which was set at the 'fast response' mode using the A-weighting curve. The microphone of the sound level meter was placed at 0.10 ± 0.01 meter from the external ear of the taxi drivers, and the ear was assessed in terms of the incoming noise received at a higher value of the equivalent continuous A-weighted sound pressure level of Leq,TdB (A). In addition, the noise exposure level was normalized to a nominal eight-hour working day, and LEX,8h was calculated based on the measured equivalent sound pressure level (Leq,T[1]), as follows [23]:

$$Leq\ 8h = 10\ log[1/8 \sum_{n}^{i} t\ (10^{\frac{leqi}{10}})] \qquad (1)$$

where Leq8h represents the equivalent noise level (dBA) during eight hours, and Leqi is the dBA of daytime and evening shifts.

2.4. Research Instrument

Data were collected anonymously using a questionnaire consisting of two sections; the first section contained sociodemographic data, including age, education level, driving hours per day, driving experience, and driving experience in the selected routes. The second section included questions on driving behaviors. The driving behaviors of the participants were evaluated using the Manchester driving behavior questionnaire (MDBQ), which was developed by Alavi et al. (2016), at Manchester University (UK) in 1990 [24].

Furthermore, the driving behavior questionnaire (DBQ) by was translated, and 293 drivers were examined to confirm the reliability and correlation-coefficients of all the subscales. The reliability was determined to be high for Iranian drivers. The coefficients included intentional violations (0.86), unintentional violations (0.65), lapses (0.77), and errors (0.81) [25]. DBQ consisted of 50 items that were scored within the range of 0-5 (Never = 0, Hardly = 1, Occasionally = 2, Mostly = 3, Frequently = 4, Always = 5). Moreover, this questionnaire had four components of violations, unintentional violations, errors, and lapses, the reliability of which has been estimated at 59%, 81%, 82%, and 66% respectively by Gras et al. (2006) [18].

2.5. Statistical Analysis

Data analysis was performed in STATISTICA software and SPSS version 23 using descriptive statistic, including mean and standard deviation (SD), minimum and maximum values for numeric variables, and percentage (relative numbers) for categorical variables. The associations between the parametric data were measured using Pearson's correlation-coefficient, and linear logistic regression was performed to calculate the odds ratios (Ors) for the behavioral components regarding the variables of noise exposure. In all the statistical analyses, P-value of less than 0.05 was considered significant.

3. Results and Discussion

In total, 70 participants were selected from 80 subjects and enrolled in the study. The results of noise measurement indicated that the mean noise levels and some personal characteristics were unfavorable in the drivers. Mean age of the study population was estimated at 46 years. All the subjects were married, and 84.3% had low education levels with eight years of driving experience and 5.7 years of driving experience in the selected routes (Table 1).The results of noise measurement are presented in Table 2, and data on the components of driving behaviors are shown in Table 3.

The normality of data was assessed using the Kolmogorov-Smirnov test ($P > 0.05$). Considering the normal distribution of data, we used parametric statistical tests. Correlations between the behavioral components, noise exposure variables, and demographic data are presented in Table 4.

According to the findings, the components of driving behaviors were significantly correlated with noise exposure ($P < 0.05$).

Table 1: Sociodemographic characteristics of drivers

Variable	Group	%	Mean ± SD
Marital Status	Married	100	
Age (year)	≤ 45 year	45.7	5.33 ± 46.13
	46-55 year	50	
	≥ 56 year	4.3	
Educational Status	Sub diploma	84.3	
	diploma	12.9	
	> diploma	2.9	
Driving Experience	≤5 year	22.9	3.43 ± 8
	6-10 year	55.7	
	≥11 year	21.4	
Driving Experience (In the selected route)	≤ 5 year	54.3	3.1 ± 5.7
	6-10 year	38.6	
	≥ 11 year	7.1	

Table 2: General acoustical characteristics of investigated municipality

Acoustical characteristics	Mean ± SD	Minimum	Maximum
Daytime LeqT (dBA)	78.87 ± 09	76.75	79.99
Evening LeqT (dBA)	80.73 ± 0.73	79.20	81.52
Leq8h	79.9 ± 0.79	78.20	80.77

Table 3: Components of driving behaviors

Components (Score Limits)	Mean ± SD	Score Ratings	%
Slip (range: 0 -105)	74.21 ± 3.71	≥ 70.5	15.7
		70.51 - 74.21	28.6
		74.22 - 77.92	41.7
		≤ 77.93	14.3
Errors (range: 0 - 45)	36.77 ± 3.61	≥ 33.16	20
		33.17 - 36.77	27.1
		36.77 - 39.87	37.1
		≤ 39.88	15.7
Intentional Violations (range: 0 - 85)	72.2 ± 4.85	≥ 67.34	24.3
		67.35 - 72.19	17.1
		72.2 - 77.04	45.7
		≤ 77.05	12.9
Unintentional Violations (range: 0 - 15)	7.36 ± 2.34	≥ 5.02	22.9
		5.03 - 7.36	31.4
		7.37-9.7	27.1
		≤ 9.71	18.6
Total Score of Driving Behaviors (range: 0 - 250)	190.53 ± 12.6	≥ 177.96	14.3
		177.97-190.53	27.1
		190.54 - 203.1	42.9
		≤ 203.11	15.7

According to the obtained results, age was significantly correlated with intentional and unintentional violations, as well as the total score of driving behaviors. Furthermore, driving experience in the selected routes was significantly correlated with errors, intentional violations, unintentional violations, and the total score of driving behaviors. Assessment of the predictive power of the variables related to noise also indicated a significant association with driving behaviors in the logistic regression analysis (Table 5).

Road traffic noise is often considered an ambient stressor , which increases the risk of adverse health effects [26, 27]. Road traffic noise is a chronic, negatively valued, non-urgent, physically perceptible, and indomitable stressor [26]. Therefore, the combination of noise exposure with other social or psychological stressors could decrease the adaptation capacities of individuals, while increasing the risk of adverse health effects [27].

Table 4: Pearson's correlation-coefficients for associations of noise variables and demographic characteristics with driving behavior components

Driving Behavior Components	Noise and Demographic Characteristics						
	Four-hour Equivalent in Morning	Four-hour Equivalent in Evening	Eight-hour Equivalent (total shifts)	Age	Experience of Driving	Experience of Driving in Selected Routes	Education Level
Slips	< 0.001	< 0.001	< 0.001	0.400	0.620	0.420	- 0.470
Errors	< 0.001	< 0.001	< 0.001	0.100	0.170	0.030	- 0.290
Intentional violations	< 0.001	< 0.001	< 0.001	0.000	0.130	0.010	- 0.870
Unintentional violations	< 0.001	< 0.001	< 0.001	0.000	0.100	0.000	- 0.490
Driving behaviors	< 0.001	< 0.001	< 0.001	0.000	0.200	0.040	- 0.500

Table 5: Logistic regression of behavioral components regarding eight-hour equivalent noise level (Leq8h)

Behavioral Component	*P* value	F	df	β
Slips	< 0.001	71.64	1	0.716
Errors	< 0.001	179.61	1	0.852
Intentional violations	< 0.001	225.71	1	0.877
Unintentional violations	< 0.001	32.26	1	0.567
Driving behaviors	< 0.001	229.74	1	0.878

The main innovations of the present study were the assessment of noise exposure in taxi drivers, using full-time noise dosimetry for this purpose, and investigating the correlations between noise exposures and driving behaviors in taxi drivers. The level of 85 dB (A) is the current guideline proposed by the World Health Organization (WHO) for acceptable noise levels at workplaces with high noise exposure levels. The values recorded in the current research were at the threshold of less than 85 dB (A). However, our findings indicated that traffic noise has significant adverse effects on driving behaviors. On the other hand, the NR 17 standard (regulation act 17: ergonomics) has established that the noise exposure levels exceeding 65 dB (A) during eight hours of work are unfavorable. Therefore, the recorded values should not be considered optimal for health and should decrease in order to improve the work environment of the taxi drivers that are exposed to such noise levels [28].

According to the results of the present study, noise exposure in taxi drivers in the evening is more common compared to the morning. This could be due to the fact that there are more vehicles in urban areas in the evening and at nighttime. This finding is in line with the study by Jakovljevic et al. (2009) which indicated that the number of vehicles during nighttime and daytime was correlated with behavioral components in drivers [29]. Furthermore, the analysis of the effects of age in this regard has shown a significant association between age and intentional and unintentional violations of driving, showing that older drivers are more likely to violations compared to younger drivers. One of the possible explanations for this finding is the fact that increased age is associated with decreased adaptation capacities with environmental factors such as noise. In contrast, the study by Zhang et al. (2016) (3) demonstrated that the strength of the correlation decreased significantly with age. Anger while driving has also been reported to have a stronger correlation with high-risk driving in young drivers compared to elderly drivers [30].

In the study by Emamjomeh et al. (2011) [20], equivalent sound level in Qazvin (Iran) was reported to be 69.9-72.8 db, which was lower than the findings of the current research. In other words, road traffic noise is on the rise with increased population and road traffic.

This meta-analysis had several limitations, such as small sample size in one route; therefore, they should not be generalized to drivers in all communities. Moreover, previous studies with consistent findings could not be found in the literature.

4. Conclusion

According to the results, there was a significant correlation between noise exposure in taxi drivers in the morning, in the evening, and eight-hour equivalent with the components of driving behaviors. The measured level of noise affecting the taxi drivers indicated that the number of vehicles were in accordance with Brazilian occupational standard in the workplace of bus drivers, which is above the accepted limits for workplaces. Therefore organizational changes in the workplace and taking noise control measures could enhance work environments for these professionals. These findings are useful for future research to address the need for defining noise exposure limit for taxi drivers in order to improve their work environment.

Authors' Contributions

A.S.V. and S.A., study design; E.A. and Z.J., field work; data analysis, and drafting of the manuscript.

Conflict of Interest

The author report no conflict of interest.

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References

1. Lera-López F, Sánchez M, Faulin J, Cacciolatti L. Rural Environment Stakeholders and Policy Making: Willingness to Pay to Reduce Road Transportation Pollution Impact in the Western Pyrenees. *Transp Res D: Transp Environ*. 2014; 32: 129-42.

2. Ricardo AE. Update of The Handbook on External Costs of Transport. *Final Report: In Report for the European Commission*; 2014; 1.

3. World Health Organization (WHO). Burden of Disease from Environmental Noise. *Bonn: WHO and JRC*. Available from: URL:

http://www. euro. who. int/data/assets/pdf-file/0008/136466/e94888. pdf, 2011.

4. Sørensen M, Andersen ZJ, Nordsborg RB, Jensen SS, Lillelund KG, Beelen R, et al. Road Traffic Noise and Incident Myocardial Infarction: a Prospective Cohort Study. *PLoS One*. 2012; 7(6): e39283.

5. Sørensen M, Andersen ZJ, Nordsborg RB, Becker T, Tjønneland A, Overvad K, et al. Long-Term Exposure to Road Traffic Noise and Incident Diabetes: a Cohort Study. *Environ Health Perspect*. 2012; 121(2): 217-22.

6. World Health Organization (WHO). Burden of Disease from Environmental Noise: Quantification of Healthy Life Years Lost in Europe, in Burden of Disease from Environmental Noise: Quantification of Healthy Life Years Lost in Europe. *World Health Organization: Genev*; 2011; 126.

7. Nassur AM, Léger D, Lefèvre M, Elbaz M, Mietlicki F, Nguyen P, et al. The Impact of Aircraft Noise Exposure on Objective Parameters of Sleep Quality: Results of the DEBATS Study in France. *Sleep Med*. 2018; 54: 70-7.

8. The European Environment Agency (EEA). Road Traffic Remains Biggest Source of Noise Pollution in Europe. Available from: URL: http://www.eea.europa.eu/highlights/roadtraffic- remains-biggest source/?utm_medium=email&utm_campaign=NoisePollution&utm_content=NoisePollution+CID_24a9ddf571cad239903cb68f54679281&utm_source=EEA%20Newsletter&utm_term=Read%20more.

9. The European Environment Agency (EEA). *Noise*. Available from: URL: http://www.eea. europa.eu/soer-2015/europe/noise.

10. Hänninen O, Knol AB, Jantunen M, Lim TA, Conrad A, Rappolder M, et al. Environmental Burden if Disease in Europe: Assessing Nine Risk Factors in Six Countries. *Environ Health Perspect*. 2014; 122(5): 439-46.

11. KryterKD. The Effects of Noise on Man. *New York: Academic Press;* 2013.

12. Broadbent DE . Perception and Communication. *Cambridge*: 1958.

13. Jerison HJ, Jerison I. Intelligence and Evolutionary Biology. *Guelph: Ontario Nig 2wl;* 2013.

14. Zimmerman K, Jinadasa D, Meagga B, Guerrero A. Road Traffic Injury on Rural zin Tanzania: Measuring the Effectiveness of Road Safety Program. *Traffic Inj Prev*. 2015; 16(5): 456-60.

15. Ainy E, Soori H, Ganjali M, Le H, Baghfalaki T. Estimating Cost of Road Traffic Injuries in Iran Using Willingness to Pay (WTP) Method. *PLoS One*. 2014; 9(12): e112721.

16. Peden M. World Report on Road Traffic Injury Prevention. *World Health Organization: Genev*; 2004.

17. Lajunen T, Parker D, Summala H. The Manchester Driver Behavior Questionaire: a Cross-Cultural Study. *Accid Anal Prev*. 2004; 36(2): 231-8.

18. Gras ME, Sullman MJ, Cunill M, Planes M, Aymerich M, Font-Mayolas S. Spanish Drivers and Their Aberrant Driving Behaviors. *Transp Res F Traffic Psychol Behav*. 2006; 9(2): 129-37.

19. Kheirabadi GR, Bolhari J. Role of Human Factors in Road Accidents. *J Res Behav Sci*. 2012; 1 (21): 69-78.

20. Emamjomeh M, Nikpay A, Safari VA. Study of Noise Pollution in Qazvin (2010). *J Qazvin Univ Med Sci*. 2011; 1 (58): 62-9.

21. Standardization ISO 9612, Edition 2. Acoustics Determination of Occupational Noise Exposure- Engineering Method. *Int Organization Stand*. 2009: 43.

22. Jamalizadeh Z, Variani AS, Asivandzadeh E, Ahmadi S. The Association between Road Traffic Noise Exposure and Annoyance. *J Air Pollut Health*. 2018; 3(1): 17-24.

23. Standardization IOf, Edition 2. Acoustics: Determination of Occupational Noise Exposure and Estimation of Noise-Induced Hearing Impairment. *Int Organization Stand*; 1990.

24. Alavi SS, Mohammadi M, Soori H, Kalhori SM, Sepasi N, Khodakarami R, et al. Iranian Version of Manchester Driving Behavior Questionnaire (MDBQ): Psychometric Properties. *Iran J Psychiatry*. 2016; 11(1): 37.

25. Oraizi H, Haghaigh S. Manchester Driving Behavior Questionnaire Psychometric Properties. *J Paiesh*.2009; 9: 21-8.

26. Campbell JM. Ambient stressors. *Environ Behav*. 1983; 15(3): 355-80.

27. Wallenius MA. The Interaction of Noise Stress and Personal Project Stress on Subjective Health. *J Environ Psychol*. 2004; 24(2): 167-77.

28. Kloimüller I, Karazman R, Geissler H, Karazman-Morawetz I, Haupt H. The Relation of Age, Work Ability Index and Stress-Inducing Factors among Bus Drivers. *Int J Ind Ergon*. 2000; 25(5): 497-502.

29. Jakovljevic B, PaunovicK, BelojevicG. Road-Traffic Noise and Factors Influencing Noise Aannoyance in an Urban Population. *Environ Int*. 2009. 35(3): 552-6.

30. Zhang T, Chan AH. The Association between Driving Anger and Driving Outcomes: A Meta-Analysis of Evidence from the Past Twenty Years. *Accid Anal Prev*. 2016; 90: 50-62.