Journal of Engineering and Applied Sciences 11 (5): 1085-1090, 2016
ISSN: 1816-949X


# Measuring Noise Pollution in High-Traffic Streets of Birjand

[1]Mojtaba Afsharnia, [1]Hamed Biglari, [2]Mohsen Poursadeghiyan,
[1]Roghieh Hojatpanah, [3]Parviz Ghandehari and [1]Ali Firoozi
[1]Department of Environmental Health Engineering, Faculty of Public Health,
Social Development and Health Promotion Research Center,
Gonabad University of Medical Sciences, Gonabad, Iran
[2]Department of Ergonomics, School of Rehabilitation,
University of Social Welfare and Rehabilitation Sciences, Tehran, Iran
[3]Department of Environmental Health Engineering, Student Research Committee,
Faculty of Public Health, Gonabad University of Medical Sciences, Gonabad, Iran

**Abstract:** The examination and control of noise pollution in urban areas can have significant positive effects on the health and social wellbeing of residents. This study investigated the noise pollution in high-traffic streets of Birjand city. This investigation was carried out by using a TES sound meter to measure the equivalent sound level during four time periods of morning, noon, evening and night at several stations. The collected data was then analyzed with SPSS and results were reported. These results showed that the average sound levels observed in all stations are above the standard level ($p>0.05$). A statistically significant difference was found between the average sound pressure levels of different time periods ($p<0.05$) and the highest average sound pressure level was observed in time period of noon. The highest and lowest average sound pressure levels were observed, respectively in Motahari St. station during noon (84.40 dB) and Shohada St. station during morning (77.23 dB). The highest equivalent sound level in morning, evening and night was observed in Taleghani St., but the highest equivalent sound level in noon was observed in Motahari St. The results of this study showed that noise pollution in Birjand City is higher than national standards and that most of this pollution is caused by traffic of vehicles.

**Key words:** Noise, sound, traffic, street, Birjand, pollution

## INTRODUCTION

The recent decades have been witness to emergence of environmental pollution as a substantial and significant global problem (Ghanbari *et al*., 2011; Stansfeld and Matheson, 2003). Noise pollution is the set of undesirable sounds (called noise) produced by the industry, machinery and equipment and propagating through the environment (Zuo *et al*., 2014; Basner *et al*., 2014). Those noises that are within the human's hearing threshold could become very annoying and potentially detrimental (Moudon, 2009). Exposure to excessive noise can seriously damage the animal and human hearing and is an important factor reducing the health and life quality of residents of large cities (Oveisi, 2007). Most common adverse effects of noise pollution include neurological and metabolic diseases such as sleep disorders, stress, high blood pressure, irritability and cardiovascular diseases (Esmaeelpour *et al*., 2014; Sazgarnia *et al*., 2005; Hammer *et al*., 2014; Barcelo *et al*., 2016). Recent studies have shown that >30% of European residents are exposed to noises higher than 55 dB and 20% are exposed to noise higher than 65 dB during the day and complain about conditions such as sleep disorder (Muzet, 2007). Other studies have found a relationship between the noise pollution produced by road traffic and the increase in blood pressure and heart attacks in adults and decrease in learning and memorization capability of children living within 100 m of primary highways with noise levels of higher than 70 dB (Lee *et al*., 2014). Some studies have reported that the level of stress and irritability increases with the increase of noise pollution (Jakovljevic *et al*., 2009; Mohammadi, 2015). In a study by Murthy *et al*. (2007) carried out in Banepa, the main cause of noise pollution was found to be the traffic of motorized vehicles. In a study by Seto *et al*. (2000) traffic of vehicles

**Corresponding Author:** Ali Firoozi, Department of Environmental Health Engineering, Faculty of Public Health, Social Development and Health Promotion Research Center, Gonabad University of Medical Sciences, Gonabad, Iran

was reported as the main cause of noise in the urban environment; this study also reported that a tenfold increase in the traffic increase the urban noise by 6.7 dB. In a study by Patak *et al*. (2008) on the city of Varanasi, it was found that noise level is so high that 85% of the people are irritated by traffic noise and about 90% of resident's express noise as the main cause of headache, high blood pressure, dizziness and fatigue (Pathak *et al*., 2008). The emergence of numerous daily activities in the context of civil life has led to emergence of noise pollution as a social problem. The overall extents of noise pollution in Iran is not yet fully clear but separate studies have found growing proliferation of noise pollution in large cities of this country. Therefore, control and reduction of noise sources is a major objective of macro development plans associated with environmental issues (Esmaeelpour *et al*., 2014). This issue has also been stressed by several studies (Zannin *et al*., 2006; Moharam Nezhad and Safaripour, 2008; Pushpa *et al*., 2013). The aim of this study is to assess the level of noise pollution in the city of Birjand (Iran) and to compare it with national standards.

## MATERIALS AND METHODS

To measure the level of noise pollution, first a comprehensive map of the study area was prepared (the map pertaining to 2016). After site selection studies based on the area of the Birgand City and the land use status (residential or commercial), 4 high-traffic points were chosen for measurement. These locations were.

$$Leq = 10\log\left[\frac{1}{t_r}\sum_{t=1}^{n} 10^{\frac{LP_i}{10}}\right] \quad (1)$$

Where:

A1 = Motahari street adjacent to bus station
A2 = Montazeri street
A3 = Shohada street
A4 = Taleghani street

The TES sound meter was used to measure daily sound level, Parameters $L_{min}$, $L_{max}$ and equivalent continuous sound level in the above said stations during 6 periods (7: 30-9:30 at morning, 11:30-13:30 at noon, 15:30-17:30 at evening, 19:30-21:30 at night, 24:00-2:00 at midnight and 5:00-7:00 at early morning). These measurements were carried out in accordance with BS 7445-3-1991 and BS 7445-1-2003 standards. The parameter Leq was obtained from Eq. 1. The time of each measurement was 10 min.

Calibration was conducted at a frequency of 1 kHz and sound level of 94 and 104 dB before and after the measurements. The sound meter was installed on a tripod at a height of 1.5 m above ground level, at a distance of 3.5 m from the wall of the sidewalk and 0.5 m from the street curb, facing the source. To remove the effect of air flow, surface of the microphone was covered with protective foam. The collected data was analyzed by the t-test carried out with SPSS Software.

## RESULTS AND DISCUSSION

The aim of this study was to determine the sound pressure level in different hours, different locations and in different seasons and months and then to make a statistical comparison between results and Iran's national standards.

Table 1 shows the average sound level in three months of summer in different station during morning, noon, evening and night. Results show that in morning, evening and night, Taleghani St. had the highest sound level while in noon Motahari St. station had the highest value of this variable.

In Summer, the lowest and highest average sound levels were observed, respectively, in Shohada St. and Taleghani St. The highest average sound level observed in Summer belonged to the month of August. In Summer, Taleghani St. station had the highest sound level at noon and night and Motahari St. station had the highest sound level during evening. The results of the statistical analysis showed that there is a significant relationship between the average sound level and different time periods ($p = 0.003$). It was also found that the highest average sound level is observed during noon (Table 2).

Statistical results showed that there is a significant relationship between the average sound pressure level and different stations ($p = 0.004$) as the highest and lowest average sound pressure level were observed, respectively in Motahari St. station and Shohada St. station (Table 3).

Table 1: The average sound pressure level in Summer (dB)

| | Times | | | |
|---|---|---|---|---|
| Station | Morning | Noon | Evening | Night |
| Motahari | 8.280 | 84.40 | 82.52 | 82.08 |
| Motanzeri | 77.87 | 80.59 | 80.97 | 82.22 |
| Shohada | 77.23 | 81.83 | 80.27 | 78.82 |
| Taleghani | 80.79 | 92.92 | 82.83 | 83.13 |

Table 2: Distribution of average sound pressure level in different time periods

| | Sound pressure level | | | | |
|---|---|---|---|---|---|
| Different time periods | Number | Average±SD | F-value | df | p-value |
| Morning | 12 | 78.1±93.83 | | | |
| Noon | 12 | 82.25±9.10 | 5.28 | 3 | 0.003 |
| Evening | 12 | 81.21±9.10 | | | |
| Night | 12 | 81.01±2.36 | | | |

Table 3: Distribution of average sound pressure level in different locations

| | Sound pressure level | | | | |
|---|---|---|---|---|---|
| Different locations | Number | Average±SD | F-value | df | p-value |
| Motahari | 12 | 84.2±81.18 | | | |
| Motanzeri | 12 | 80.2±04.28 | 5.008 | 3 | 0.004 |
| Shohada | 12 | 2.11±79.36 | | | |
| Taleghani | 12 | 82.16±1.83 | | | |

Table 4: Distribution of average sound pressure level in different months

| | Sound pressure level | | | | |
|---|---|---|---|---|---|
| Different locations | Number | Average±SD | F-value | df | p-value |
| June | 12 | 80.2±56.05 | | | |
| July | 12 | 81.2±24.69 | 0.349 | 2 | 0.707 |
| August | 12 | 80.2±74.39 | | | |

Table 5: Allowed sound pressure level in outdoor environments (according to standards of Iran's environmental protection organization, 1999)

| Station type | Day from 7-22 (dBA) | Night from 22 (dBA) |
|---|---|---|
| Residential | 55 | 45 |
| Commercial-residential | 55 | 50 |
| Commercial | 65 | 55 |
| Residential and industrial | 70 | 60 |
| industrial | 75 | 65 |

The results of the ANOVA statistical analysis showed no significant difference between the values of average sound pressure level in different months ($p>0.05$) (Table 4).

According to the results shown in Table 5, the average sound level in all studied stations are higher than allowed standard ($p>0.05$). These results also show a significant difference between the average sound pressure levels in different time periods ($p>0.05$). The highest average sound pressure level was observed at the time period of noon. The highest sound pressure level, 84.40 dB, belonged to measurements made at noon in Motahari St. station. The lowest sound pressure level, 77.23 dB, belonged to measurements made at morning in Shohada St. station. The highest equivalent sound level at morning, evening and night belonged to Taleghani St. station but for time period of noon it belonged to Motahari St. station. The lowest equivalent sound level at morning, evening and night belonged to Shohada St. station but for time period of noon it belonged to Montazeri St. station (Table 3).

The results of this study showed that the highest average sound level in three months of summer belonged to Taleghani St. station and this finding is consistent with the results of a study carried out in the summer of 2011 by Moasheri *et al*. (2015) on noise pollution in Birjand. The Emam-Reza hospital and most medical offices and clinics of Birjand are located in Taleghani St. Therefore, ambulance traffic and the commute of clients and patients can be considered as an exacerbating factor for traffic and noise pollution in this street. In addition, the absence of parking lots with sufficient capacity in this street is one of the main reasons behind traffic and honking of cars. Another reason for traffic is vehicles picking up or dropping off passengers and consequent reduction in traffic speed followed by repeating honking of objecting drivers. In a similar study carried out in Kashan, the average equivalent sound level was reported to be 79.7 dB and the highest noise in high traffic areas was reported to be 81.49 dB (Kashani *et al*., 2002). Another study in Yasuj showed that in high traffic areas of this city, the sound level was higher than allowed standards; all these results are in agreement with the results of the present study (Oryad *et al*., 2008). According to our results, there is a significant difference between the average sound pressure levels in different time periods and the maximum noise pollution was observed the time period of noon. The increase of noise pollution can be due to coincide with end of office hours when people return to their homes and can be attributed to the consequent rush hour. The high level of average sound level at noon can be because of the high sound level of noise sources in some stations during specific daily activities and the dispersion of data related to these sources. Another, reason may be the higher temperature at noon in comparison to morning and night which increases the tire-asphalt adhesion and the resulting sound. In a study carried out in Birjand, the maximum average sound level recorded at noon was similar to the results of the present study. That study reported that the presence of some specific pollutants in some stations increases the standard deviation and variance and affects the total average of results. In that study, the average pollution at night was found to be higher than other time periods. In another study in the city of Sari, the average sound level was found to be 77.1 dB; that study attributed the highest sound level at morning to the start of business in markets and bazaar and the highest sound level at noon (13:00) to shift change in schools and the consequent traffic. This study also reported that in low traffic hours, mostly empty streets allow drivers to drive with a higher speed and this increases the sound pressure level (Alizadeh *et al*., 2009). Two variables of time and space can both affect the intensity of noise pollution. Analysis of the data shows that the intensity of noise pollution differs in the morning, noon, evening and night. In general, morning was found to be quieter than noon and evening was found to be quieter than night. But sound levels may vary depending on the time and location of measurement. The study of Ghanbari has also reported that maximum noise level is during the time period of noon. The study of Mosaferi *et al*. (2012) has also reported that noise level and equivalent sound level in Saheb-Al-Amr station around noon are higher than evening. They attributed this

observation to the fact that Saheb-Al-Amr Square is one of the main distribution hubs of Tabriz bazaar. A study on environmental noise pollution in the city of Curitiba in Brazil reported that 93% of stations had an average sound level of over 65 dB and 40.3% of stations had an average sound level of over 75 dB (Zannin *et al*., 2002). The results of a study carried out in Jordan reported that average sound levels measured at most stations were greater than 62 dB and exceeded the allowed levels (Jamrah *et al*., 2006). In a study by Mansouri *et al*. (2006) on Summer time noise pollution in Tehran, it was found that in 63 out of 91 measurement stations, the average equivalent sound level was higher than 70 dB; it was also reported that there is no significant statistical difference between equivalent sound level during the week and the time periods of morning, noon and evening. A study by Moasheri *et al*. (2013) on the city of Birjand compared the average sound pressure level at different stations and measured the highest average sound level in Motahari St. The results of present study which proved to be consistent with those of similar studies, indicate that considering the critical position of Motahari St. as a North-South artery passing through business and shopping centers, there is an essential need for corrective strategies and measures aimed at reducing noise pollution in this street. The low width of this street is a major cause of increased traffic and increased noise pollution. Considering the insufficiency of vegetation cover in this street, creating more green space and a green belt on the edge of the street can be expected to reduce the level of noise pollution. Although, no statistically significant differences were observed between the mean values of sound pressure level at different months ($p = 0.7$), the highest average sound pressure level belonged to August which is consistent with the results of Moasheri. Moasheri *et al*. (2013). The results of this study show that Birjand has a high noise pollution and future development and modernization of the city and population growth which will be followed by increased urban traffic can be expected to exacerbate this situation. It appears that further studies aimed at determining the causes of pollution and provision of appropriate solutions to reduce and control the situation, especially in Motahari and Taleghani stations are absolutely necessary. Considering the presence of Imam Reza Hospital in Taleghani Street and high level of noise in this station as compared to others, adopting appropriate noise pollution monitoring and control measures in this hospital is recommended. The effective noise pollution reduction measures include: creation and improvement of green space as sound absorber around high-traffic routes, concentrating commercial zones outside the residential zones, limiting urban development and construction operations to certain hours of the day, insulating the exterior surfaces of buildings, the use of double glazed doors and windows, the use of sound-absorbing acoustic materials especially in the construction of residential and commercial building positioned next to crowded and high-traffic streets, barring worn-out vehicles from entering high-traffic routes, organizing taxis operating in the city by reforming the traffic management, restricting traffic to one-way direction (when necessary) and increasing the awareness of residents living in crowded and high-traffic areas in regard with noise pollution, its consequences and the methods of reducing noise level. some of the risk assessment methods must be used for assessing the exposure of health risk factor (Yarmohammadi *et al*., 2016). We recommended effects of administrative interventions on improvement of safety and health in workplace and outdoor work must be done to reduced exposure of citizen in the city (Ebrahimi *et al*., 2016).

## CONCLUSION

In this study, noise pollution in high-traffic streets of Birjand city was investigated by measuring the equivalent sound level in four time periods of morning, noon, evening and night during Summer. The results of this study showed that the average sound levels observed in all stations are above the standard level ($p>0.05$) and most of this pollution is caused by traffic of vehicles. A statistically significant difference was found between the average sound pressure levels of different time periods ($p<0.05$) and the highest average sound pressure level belonged to time period of noon. The highest and lowest average sound pressure levels were observed, respectively in Motahari St. station during noon (84.40 dB) and Shohada St. station during morning (77.23 dB). The highest equivalent sound level in the morning, evening and night was observed in Taleghani St. but the highest equivalent sound level during noon was observed in Motahari St.

## ACKNOWLEDGEMENT

Researchers are grateful for the financial support of this project by the health research deputy of Gonabad University of Medical Sciences and technical support during this study.

## REFERENCES

Alizadeh, A., M. Mohammadian, S. Etemadinejad and J. Yazdani, 2009. Evaluation of noise pollution in sari (2007-2008). J. Mazandaran Univ. Med. Sci., 18: 45-52.

Barcelo, M.A., D. Varga, A. Tobias, J. Diaz, C. Linares and M. Saez, 2016. Long term effects of traffic noise on mortality in the city of Barcelona, 2004-2007. Environ. Res., 147: 193-206.

Basner, M., W. Babisch, A. Davis, M. Brink, C. Clark, S. Janssen and S. Stansfeld, 2014. Auditory and non-auditory effects of noise on health. Lancet, 383: 1325-1332.

Ebrahimi, M.H., M. Abbasi, M. Khandan, M. Poursadeghiyan, M. Hami and H. Biglari, 2016. Effects of administrative interventions on improvement of safety and health in workplace: A case study in an oil company in Iran (2011-2015). J. Eng. Applied Sci., 11: 346-351.

Esmaeelpour, M.R.M., M.S. Sekhavatjou and Z.C. Ahwazi, 2014. Designing a traffic noise prediction model for highways in Iranian megacities (case study: Ahvaz City). Int. J. Environ. Res., 8: 427-434.

Ghanbari, M., K. Nadafi, M. Mosaferi, M. Yunesian and H. Aslani, 2011. Noise pollution evaluation in residential and residential-commercial areas in Tabriz-Iran. Iran. J. Health Environ., 4: 375-384.

Hammer, M.S., T.K. Swinburn and R.L. Neitzel, 2014. Environmental noise pollution in the United States: Developing an effective public health response. Environ. Health Perspect., 122: 115-115.

Jakovljevic, B., K. Paunovic and G. Belojevic, 2009. Road-traffic noise and factors influencing noise annoyance in an urban population. Environ. Int., 35: 552-556.

Jamrah, A., A. Al-Omari and R. Sharabi, 2006. Evaluation of traffic noise pollution in Amman, Jordan. Environ. Monitor. Assess., 120: 499-525.

Kashani, M.M., M. Hannani, H. Akbari and H. Almasi, 2002. Noise pollution in Kashan in 2000-01. Feyz: J. Kashan Univ. Med. Sci., 6: 36-40.

Lee, E.Y., M. Jerrett, Z. Ross, P.F. Coogan and E.Y. Seto, 2014. Assessment of traffic-related noise in three cities in the United States. Environ. Res., 132: 182-189.

Mansouri, N., M. Pourmahabadian and M. Ghasemkhani, 2006. Road traffic noise in downtown area of Tehran. J. Environ. Health Sci. Eng., 3: 267-272.

Moasheri, B.N., V. Abolhasannejad, Z. Vahdatparast, S. Sharifi, R. Hojatpanah and A.A. Taghizadeh, 2015. Assessment of day average sound level index in overcrowded areas of Birjand City in 2011. J. Health, 6: 115-124.

Moasheri, N., M. Esmaeelpoore, M. Reza, V. Abolhasannejad, M. Abbaszadeh and E. Movahedi, 2013. Assessment of noise pollution indices in Birjand old districts in 2010. J. Birjand Univ. Med. Sci., 19: 439-447.

Mohammadi, G., 2015. Noise exposure inside transit buses in Kerman: Measurements, drivers and passengers attitudes. Iran. J. Health Saf. Environ., 2: 224-228.

Moharam Nezhad, N. and M. Safaripour, 2008. The impact of urban development on the noise pollution in the area of Tehran and management options for recovery. J. Environ. Sci. Technol., 4: 43-57.

Mosaferi, M., Y. Rasulzadeh, J. Nazari, H. Taghipour and I. Diyanat, 2012. Study of noise pollution in downtown area of Tabriz during heavy traffic times. Med. J. Tabriz Univ. Med. Sci. Health Serv., 34: 23-23.

Moudon, A.V., 2009. Real noise from the urban environment: How ambient community noise affects health and what can be done about it. Am. J. Prev. Med., 37: 167-171.

Murthy, V.K., A.K. Majumder, S.N. Khanal and D.P. Subedi, 2007. Assessment of traffic noise pollution in banepa, a semi urban town of Nepal. Kathmandu Univ. J. Sci. Eng. Technol., 3: 12-20.

Muzet, A., 2007. Environmental noise, sleep and health. Sleep Med. Rev., 11: 135-142.

Oryad, M.H., A.R. Shirazi and I. Alimohammadi, 2008. Evaluation of noise pollution in crowded areas in Yasuj in 2006. Armaghane Danesh, 12: 109-116.

Oveisi, A., 2007. The effects of noise pollution caused by traffic on public health and mental citizens of Yazd. Ecology, 33: 41-50.

Pathak, V., B.D. Tripathi and V.K. Mishra, 2008. Evaluation of traffic noise pollution and attitudes of exposed individuals in working place. Atmos. Environ., 42: 3892-3898.

Pushpa, K., B. Girija and S. Veeraiah, 2013. Effect of traffic noise on hearing in city bus drivers of Bangalore. Indian J. Public Health Res. Dev., 4: 227-230.

Sazgarnia, A., T.S.M.H. Bahreyni and H. Moradi, 2005. Noise pollution and traffic noise index on mashhad main streets during the busiest hours of summer. Iran. J. Med. Phys., 2: 21-30.

Seto, E.Y.W., A. Holt, T. Rivard and R. Bhatia, 2007. Spatial distribution of traffic induced noise exposures in a US city: An analytic tool for assessing the health impacts of urban planning decisions. Int. J. Health Geographics, Vol. 6. 10.1186/1476-072X-6-24

Stansfeld, S.A. and M.P. Matheson, 2003. Noise pollution: Non-auditory effects on health. Br. Med. Bull., 68: 243-257.

Yarmohammadi, H., M. Poursadeghiyan, Y. Shorabi, M.H. Ebrahimi, G. Rezaei, H. Biglari and R. Rostami, 2016. Risk assessment in a wheat winnowing factory based on ET and BA method. J. Eng. Applied Sci., 11: 334-338.

Zannin, P.H.T., A.M.C. Ferreria and B. Szeremetta, 2006. Evaluation of noise pollution in urban parks. Environ. Monit. Assess., 118: 423-433.

Zannin, P.H.T., F.B.R. Diniz and W.A. Barbosa, 2002. Environmental noise pollution in the city of curitiba, Brazil. Applied Acoustics, 63: 351-358.

Zuo, F., Y. Li, S. Johnson, J. Johnson and S. Varughese *et al*., 2014. Temporal and spatial variability of traffic-related noise in the City of Toronto, Canada. Sci. Total Environ., 472: 1100-1107.