کارکاه‌های آموزشی مرکز اطلاعات علمی جهاد دانشگاهی

کارکاه آنلاین
کاربرد نرم‌افزار SPSS در پژوهش

کارکاه آنلاین
اصول تنظیم قراردادها

کارکاه آنلاین
پروپوزال نویسی
Level Changes of Traffic Noise in Kerman City, Southeast Iran

M Malakootian¹, M Ahmadian², *K Yaghmaeian³, Sh Dowlatshahi¹, MR Ghotbi Ravandi⁴

¹Environmental Health Research Center and Dept. of Environmental Health Engineering, School of Public Health, Kerman University of Medical Sciences, Kerman, Iran
²Social Development & Health Promotion Research Center, Kermanshah University of Medical Sciences, Kermanshah, Iran
³Dept. of Environmental Health Engineering, Tehran University of Medical Sciences, Tehran, Iran
⁴Dept. of Occupational Health, Kerman University of Medical Sciences, Kerman, Iran

(Received 14 Jan 2011; accepted 26 Nov 2011)

Introduction

Noise pollution causes undesirable effects on human health and well-being in urban areas varying from simple problems such as trouble falling sleep, reading, talking, concentration to severe physiological & psychological harm (1-7). In modern societies noise pollution is identified as a serious public health problem (8). Environmental pollution such as noise & air pollution are considered as being risk factors for human health which is followed by urban technological development (9). Traffic, urban and industrial activities are among important sources of noise pollution (10). Relationship between urban traffic and human health is established in recent years (11, 12). Traffic noise is also of prime importance economically and it is estimated that there has been 1% to 5% increase in residential areas prices in some countries for every decibel noise reduction (13). During last few decades the number of motor vehicles in densely populated urban areas has increased significantly which endangers the health of the residents due to traffic noise pollution (14). In these areas due to the lack of land and financial resources, many of the highways are built in residential & commercial areas.

Abstract

Background: The purpose of this research was to determine the traffic noise level and changes in the Kerman City, southeast Iran in recent years.

Methods: This cross-sectional study was carried out in 2008 to investigate the existing noise situation in Kerman. Sound levels (L_{Max}, L_{Min}, L_{eq}, L_{99}, L_{90}, L_{50} and L_{10}) were determined throughout 13 stations using sound level measurement system (model, CEL-440). Number of passing vehicles was also assessed at the sampled stations.

Results: Sound level in all sampled stations was higher than Iran and World Health Organization guidelines. Comparison of L_{eq} in different hours using statistical tests showed significant difference between different hours with 95% confidence coefficient (P=0.01). Comparison of L_{eq} throughout the week also showed that there was a significant difference (P=0.001) between Friday and workday. The comparison of L_{eq} with the number of passing vehicles using Pearson correlation statistical test showed significant difference between the number of heavy vehicles passed and the level of L_{eq} (P=0.001). It also showed that number of heavy vehicles caused the most noise levels.

Conclusion: The results of this study compared to a similar study conducted in 1999 showed an increasingly high noise level. Noise level increased from 1999 to 2008 by 3.89% which is indicative of an increase in noise emission sources.

Keywords: Noise level, Traffic, Iran

*Corresponding Author: E-mail address: k_yaghmaeian@yahoo.com
which cause undesirable physiological & non physiological effects on people who reside in the vicinity of these highways. Noise pollution from motor vehicles is expanding at an alarming rate and will become a critical issue in the near future (15). In recent years new laws have been enacted to control the traffic noise pollution. Knowing of traffic noise pollution is one of the prime source which leads to the development of models for reduction of its effects (16). In a study conducted in London, England high percentage of the residents picked noise pollution as the most important problem of their city and 23% of them chose the traffic noise as the main source of the noise pollution (17). Based on European Union guidelines, European cities with population more than 250000 are required to provide noise strategic plans for highways, railroads and airports which have to be renewed every 5 years and every 10 years for cities with population more than 100000 (18). Scientific studies of traffic noise pollution in different parts of the world especially in European countries have resulted in passing a law in this respect. In Asian countries, however, lesser studies concerning traffic noise pollution have been conducted in the populated urban areas (19). In Canada, a great deal of studies have been carried out concerning traffic noise in densely populated cities as well as cities of average population, and based on the obtained results more studies in respect to traffic noise are recommended (20). In Iran, several studies have been done about noise pollution in highly populated cities such as Tehran and Mashhad. Kerman, one of the populated urban areas in Iran, has showed population growth in recent years. This is why increased population in Kerman necessitates fulfillment of the present study.

The purpose of this study was to determine the noise level in Kerman, its variations in recent years and the role of the traffic in the increase of the noise level.

Materials and Methods

This cross-sectional study was conducted in 2008. In order to determine the sound level, 13 stations were selected based on sound map of the city of Kerman, southeast Iran. Sampled stations covered all city areas and were in agreement with the selected stations in previous study (21). In these stations, different noise factors such as $L_{\text{Max}}, L_{\text{Min}}, L_{eq}, L_{99}, L_{90}, L_{50}$ and $L_{10}$ were measured on every Saturday, Tuesday and Friday for one year. Measurement was performed at 7-8 am, 1-2 pm and 7-8 pm of selected days.

In order to measure the sound level the microphone of sound level meter was installed inside the street at the height of 1.2 m above ground level and at the distance of 1.5 m from curb to prevent the effect of surrounding trees & buildings. In order to prevent the wind effect of traffic and surroundings on measured sound level a wind screen has been added to the microphone. Wind screen has no effect on the sound level received by the microphone and is used to protect microphone against dust effect.

Before each measurement, the sound level meter (CELL 440, model) was calibrated and was set on A-weighting network and fast response with every 5 min measurement time.

It should be noted that the sound level meter is capable of simultaneous measuring of all 7 levels from the memory read out of the instrument at the end of the 5 min measuring time. 5616 measurements were totally conducted in all stations.

Measurement was done on three days of the week and at three times of day in each station. In other word the number of measurement was 36 per month and 432 per year in each station. The annual average noise level was obtained from dividing the sum of the measured levels by 432 in each station.

Number of passing vehicles was counted during the time of each measurement at each station. The results obtained from this study were ana-
lyzed using ANOVAs, Tukey and Pearson correlation coefficient statistical tests.

**Results**

The average of noise levels in 13 stations is shown in Table 1. Table 2 shows the number of passing vehicles throughout the selected stations during the time of noise level measurements. The average of noise levels in different days of the week and different hours of day were presented in Table 3 and 4.

![Fig. 1: Equivalent noise level ($L_{eq}$) at 13 stations in 1999 and 2008](image)

**Table 1: Average of noise levels in 13 stations dB(A)**

| Station Number | $L_{99}$ | $L_{90}$ | $L_{10}$ | $L_{A1nn}$ | $L_{eq}$ | $L_{Max}$ |
|----------------|----------|----------|----------|------------|----------|-----------|
| 1              | 73.6     | 75.6     | 78.4     | 81.7       | 72       | 79.5      | 90.9      |
| 2              | 71.6     | 73.8     | 76.5     | 79.7       | 69.9     | 77.7      | 89.8      |
| 3              | 73.5     | 75.3     | 77.8     | 81.2       | 71.7     | 79.1      | 90.2      |
| 4              | 71.1     | 73.1     | 75.9     | 79.4       | 69.4     | 77.2      | 89.1      |
| 5              | 72.8     | 75.1     | 77.7     | 81.1       | 71.2     | 78.9      | 89.9      |
| 6              | 75.9     | 77.9     | 80.5     | 84.1       | 73.5     | 81.6      | 93.5      |
| 7              | 77.2     | 79.4     | 82.1     | 85.7       | 75.2     | 83.3      | 95.3      |
| 8              | 76.3     | 78.5     | 81.4     | 85         | 74.7     | 82.8      | 94.6      |
| 9              | 73.3     | 76.4     | 79.1     | 82.8       | 72.3     | 80.8      | 91.5      |
| 10             | 73.5     | 75.6     | 78.9     | 82.8       | 72       | 80.8      | 92.9      |
| 11             | 71.5     | 74.2     | 77.1     | 80.5       | 70       | 78.4      | 92.9      |
| 12             | 72.5     | 74.8     | 77.5     | 81         | 70.9     | 78.5      | 88.9      |
| 13             | 74.7     | 76.9     | 79.8     | 83.6       | 73       | 81.2      | 93.4      |

**Table 2: Number of passing vehicles in selected stations during the time of noise level measurements**

| Station Number | Saturday | Tuesday | Friday | Average |
|----------------|----------|---------|--------|---------|
|                | Light    | Heavy   | Light  | Heavy   | Light  | Heavy |
| 1              | 4391     | 102     | 4413   | 104     | 3159   | 30    | 3987   | 78    | 4065  |
| 2              | 5784     | 56      | 5071   | 48      | 3166   | 24    | 4673   | 42    | 4715  |
| 3              | 4985     | 103     | 2866   | 55      | 1700   | 31    | 3183   | 63    | 3246  |
| 4              | 3716     | 69      | 3390   | 57      | 2863   | 42    | 3323   | 56    | 3379  |
| 5              | 2193     | 66      | 2143   | 42      | 858    | 31    | 1731   | 46    | 1777  |
| 6              | 3100     | 347     | 3280   | 375     | 650    | 127   | 2343   | 283   | 2626  |
| 7              | 4478     | 484     | 4482   | 483     | 1755   | 207   | 3571   | 391   | 3962  |
| 8              | 3796     | 403     | 3087   | 427     | 1260   | 124   | 2714   | 318   | 3032  |
| 9              | 4357     | 76      | 4016   | 71      | 2112   | 28    | 3495   | 58    | 3553  |
| 10             | 5900     | 56      | 5424   | 47      | 3901   | 38    | 5075   | 47    | 5122  |
| 11             | 4720     | 89      | 3087   | 102     | 2616   | 58    | 3474   | 83    | 3557  |
| 12             | 2945     | 16      | 1389   | 14      | 1821   | 8     | 2051   | 12    | 2063  |
| 13             | 3753     | 123     | 3404   | 109     | 2628   | 16    | 3261   | 82    | 3343  |
Table 3: Average of noise levels in different days of week dB(A)

|       | Saturday   | Tuesday   | Friday   |
|-------|------------|-----------|----------|
| L_{99}| 73.8±3.29  | 74.11±2.65| 71.68±3.02|
| L_{90}| 75.99±3.11 | 76.28±2.54| 73.84±2.70|
| L_{50}| 78.80±2.94 | 79.1±2.49  | 76.47±2.69 |
| L_{10} | 82.47±2.83 | 82.53±3.1  | 79.93±2.62 |
| L_{Min}| 72.12±3.27 | 72.25±3.25 | 70.07±2.8 |
| L_{eq} | 80.16±2.83 | 80.34±2.55 | 77.86±2.59 |
| L_{max}| 91.69±2.2  | 91.49±1.98 | 89.26±2.23 |

Table 4: Average of noise levels in different times of day dB(A)

|       | 7-8 am     | 1-2 pm     | 7-8 pm     |
|-------|------------|------------|------------|
| L_{99}| 73.52±2.99 | 73.17±2.85 | 72.95±3.64 |
| L_{90}| 75.7±2.95  | 75.38±2.64 | 74.99±3.32 |
| L_{50}| 78.52±2.9  | 78.09±2.77 | 77.75±3.14 |
| L_{10} | 81.6±3.03  | 81.58±2.68 | 81.19±3.47 |
| L_{Min}| 71.7±3.09  | 71.45±2.93 | 71.26±3.72 |
| L_{eq} | 79.91±3.03 | 79.29±2.69 | 79.15±2.89 |
| L_{max}| 91.22±2.42 | 90.80±2.23 | 90.42±2.25 |

Table 5: Noise level standards of some countries

| Country         | Industrial Area Days/Night | Commercial Area Days/Night | Residential Area Days/Night | Quite Area Days/Night |
|-----------------|-----------------------------|-----------------------------|----------------------------|-----------------------|
| Australia       | 65.55                       | 55.45                       | 45.35                      | 45.35                 |
| India           | 75.70                       | 65.55                       | 55.45                      | 50.40                 |
| Japan           | 60.50                       | 60.50                       | 50.40                      | 45.35                 |
| U.S. (E.P.A.)   | 70.60                       | 60.50                       | 55.45                      | 45.35                 |
| WHO guidelines  | 65                          | 55                          | 55.45                      | 45.35                 |

Discussion

In comparing L_{eq} between different times of day using ANOVAs and Tukey statistical tests, a significant difference has been reported between 7-8 am and 7-8 pm with 95% confidence level (P = 0.01). However, no significant difference was found between 7-8 am and 1-2 pm with 95% confidence level (P = 0.059). Between 1-2 pm and 7-8 pm with 95% confidence level no significant difference were also detected (P = 0.082). By comparing L_{eq} between different days of week, a significant difference was found between Friday with Saturday and Tuesday with 95% confidence level (P = 0.000). However, there was no significant difference between Saturday and Tuesday. By comparing L_{eq} with the number of passing heavy vehicles at each station, using the Pearson correlation test, a significant difference was found (P = 0.001). The results showed that a sound level in all stations was higher than Iran and WHO allowed guidelines. Among the stations, Station No. 7 showed the highest annual equivalent sound level (L_{eq}) due to the high rate of heavy vehicle traffic. Results showed that with increasing the number of heavy vehicles, noise level has been increased in comparison with the light vehicle traffic stations. The peak traffic hour in the most stations was between 7 to 8 am. Reduction of the number of passing vehicles in all stations in Friday (holiday) compared with
Saturday and Sunday is the reason for lesser noise level in holidays. Results of this study were compared with that of similar research performed at the same stations in 1999 (21). As shown in Fig. 1, annual equivalent noise level (L<sub>eq</sub>) has increased in all stations. During this period, the total number of motor vehicles in Kerman is increased from 114,022 in 1999 to 557,319 in 2008 (22, 23). Increasing the rate of noise during the recent years is due to the increasing of passing vehicles.

Table 5 shows the noise level standard in some countries of the world and WHO (24). In the present study, average Leq in all stations was equal to 79.9 dB (A). Station No. 7 showed the highest annual average Leq with 83.3 dB (A) and the lowest Leq annual average was equal to 77.2 dB(A) at station No.4. In a study conducted in Yazd (Iran) in 2006, the highest amount of L<sub>eq</sub> was equal to 79 dB (A) with 71.4 dB (A) the lowest amount of L<sub>eq</sub> (25). In another study in 2006 in the south of Tehran (capital of Iran) L<sub>eq</sub> was equal to 78.5 dB(A) (26). The highest Leq average in a study in Mashhad (Iran) in 2003 was equal to 78.5 dB(A) (27). In Sari (Iran) in 2007, the Leq average was equal to 77.1 dB (A) and maximum and minimum level of L<sub>eq</sub> recorded 62 and 92.3 5 dB(A) respectively (28). The Leq average in south Tehran, Yazd and Mashhad was lower than that of Kerman. In a research done in Kashan (Iran) in 2000 in a heavy traffic area, the maximum L<sub>eq</sub> was 81.7±1.4 dB(A) and the Leq average was 79.7± 2.6 dB(A) ( higher than Kerman)(29).

In a study conducted in Asansol, India the L<sub>eq</sub> values have been reported 51.2 to 89 dB (A) (30). In another study in Alexandria (Egypt) the L<sub>eq</sub> values were between 74.2 and 83.7 dB (A) (31). In both cases, the L<sub>eq</sub> average was higher than that of Kerman. In a study done in Kaunas, Lithuania in 2006 in the light traffic stations with more passing heavy vehicles, the measured noise levels were higher than the others. In this study, the maximum amount of L<sub>eq</sub> was 74.7 dB (A) (32). Average daily values of L<sub>eq</sub> in 2005 were 77.2 ± 4.6 in Belgrade (Serbia) (33). Overall, the L<sub>eq</sub> values recorded not only in Kerman and other cities of Iran, but also in other countries indicated that traffic noise in cities was higher than the international standard values.

**Ethical considerations**

Ethical issues (Including plagiarism, Informed Consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc) have been completely observed by the authors.

**Acknowledgements**

This study was financially supported by Research Deputy of Kerman University of Medical Sciences. The authors would also like to thank the Environmental Health Research Center for approval of the research. The authors declare that there is no conflict of interests.

**References**

1. Dawson D (2005). The problem of noise and the solution of sound. *Intensive and Critical Care Nursing*, 21: 197-198.
2. Muzat A (2007). Environmental noise, sleep and health. *Sleep Medicine Reviews*, 11: 135-142.
3. Ronen P, Sharon F, Haim S (2004). Effect of an initial noise induced hearing loss. *Hearing Research*, 192: 101-106.
4. Kjellberg A, Landstrom U, Tesarz M (1996). The effects of nonphysical noise characteristics, ongoing task and distraction due to noise at work. *Journal of Environmental Psychology*, 16: 123-136.
5. Quehl J, Basner M (2006). Annoyance from nocturnal aircraft noise exposure: laboratory and field-specific dose response curves. *Journal of Environmental Psychology*, 26: 127-140.
6. Belojevic B, Ohstrom E, Rylander R (1992). Effects of noise on mental performance
with regard to subjective noise sensitivity. *Int Arch Occup Environ Health*, 64: 293-301.

7. Rahmani S, Mousavi SM, Kamali MJ (2011). Modeling of road-traffic noise with the use of genetic algorithm. *Applied Soft Computing*, 11: 1008-1013.

8. Doui S (2001). Annoyance from road traffic noise: a review. *Journal of Environmental Psychology*, 21: 101-120.

9. Barbosa ASM, Cardoso MRA (2005). Hearing loss among worker exposed to road traffic noise in the city of Sao Paulo in Brazil. *Auris Nasus Larynx*, 32: 17-21.

10. Salvato JA, Nemerow NL, Agardy FJ (2003). *Environmental Engineering: Noise Control*, 5th ed, John Wiley & Sons Inc. New York, pp. 950-976.

11. Coyle E et al. (2008). Transport and health - a five- country perspective. *Public Health*, 123(1): 1-3.

12. Marka AB, Swanson E (2007). Auditory masking of anuran advertisement calls by road traffic noise. *Animal Behavior*, 74: 1765-1776.

13. Fyhri A, Klaeboe R (2006). Direct, indirect influences of income on road traffic noise annoyance. *Journal of Environmental Psychology*, 26: 27-37.

14. Akhtar NH, Zahir Shah M, Qamar I (1998). Road traffic noise in Peshawar- an increasing problem. *Journal of Postgraduate Medical Institute*, 12(2): 58-64.

15. Alimohammadi I, Nassiri P, Behzad M, Hosseini MR (2005). Reliability analysis traffic noise estimation in highways of Tehran by Monte Carlo simulation method. *Iranian Journal of Environmental Health Science & Engineering*, 2(4): 229-236.

16. Golmohammadi R, Abbaspour M, Nassiri P, Mahjub H (2009). A compact model for prediction road traffic noise. *Iranian Journal of Environmental Health Science & Engineering*, 6(3): 181-186.

17. Alesheikh AA, Omidvari M (2010). Application of GIS in Urban Traffic Noise Pollution. *International Journal of Occupational Hygiene*, 2(2): 87-92.

18. Ko JH, Chang SI, Kim M, Holt JB, Seong JC (2011). Transportation noise and exposed population of an urban area in the Republic of Korea. *Environment International*, 37: 328-334.

19. Lee SW, Chang SI, Park YM (2008). Utilizing noise mapping for environmental impact assessment in a downtown redevelopment area. *Applied Acoustics*, 69: 704-14.

20. Dai L, Cao J, Fan L, Mobed N (2005). Traffic noise evaluation and analysis in residential areas of Regina. *Journal of Environmental Informatics*, 5(1): 17-25.

21. Malakootian M (2001). Noise pollution in Kerman-Iran. *Iranian J Publ Health*, 30(1-2): 31-36.

22. Iran Police Force (2008). Plan and budget assistance. Bureau of Statistics.

23. Malakootian M. Environmental assessment of Haft Bagh project, Kerman. [PhD thesis]. School of Public Health, Tehran University of Medical Sciences, Iran; 2000.

24. Chauhan A, Pande KK (2010). Study of noise level in different zones of Dehradun City, Uttarakhand. *Report and Opinion*, 2(7): 65-68.

25. Oveyssi A, Ismail Sari A, Ghasempouri M (2006). Considering and measurement noise traffic in the Yazd city (Iran). *Iranian Journal of Natural Resources College*, 59(4): 885-901.

26. Mansouri N, Pourmahabadian M, Ghasemkhani M (2006). Road traffic noise in down town area of Tehran, Iran. *Int Arch Occup Environ Health*, 3(4): 267-272.

27. Sazgarnia A, Tousi SMHB, Moradi H (2005). Noise pollution and traffic indexes in several main streets in Mashhad city at busiest hours of summer. *Iranian Journal of Medical Physics*, 2(8): 21-30.

28. Alizadeh A, Mohammadian M, Etemadinejad S, Yazdani j (2009). Evaluation of noise pollution in Sari city. *Journal of Mazandaran University of Medical Sciences*, 19(69): 45-52.

29. Kashani MM, Hanani M, Akbari H, Almasi H (2002). Evaluation of noise pollution in Kashan city from 2000 to 2001. *Jour-
nal of Kashan University of Medical Sciences, 21: 30-36.
30. Banerjee D, Chakraborty SK, Bhattacharyya S, Gangopadhyay A (2008). Evaluation and analysis of road traffic noise in Asansol: an industrial town of eastern India. International Journal of Environmental Research and Public Health, 5(3): 165-171.
31. Ghatass ZF (2009). Assessment and analysis of traffic noise pollution in Alexandria City, Egypt. World Applied Sciences Journal, 6(3): 433-441.
32. Baubonite I, Grazuleviciene R (2007). Road traffic and environmental noise in Kaunas city. Environmental Research Engineering and Management, 1(39): 49-54.
33. Jakovljevic B, Belojevic G, Paunovic K, Stojanov V (2005). Road traffic noise and sleep disturbances in an urban population: cross-sectional study. Croatian Medical Journal, 47: 125-33.
