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Original Article

Level Changes of Traffic Noise in Kerman City, Southeast Iran

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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

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 have 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

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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_{Max}, L_{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.

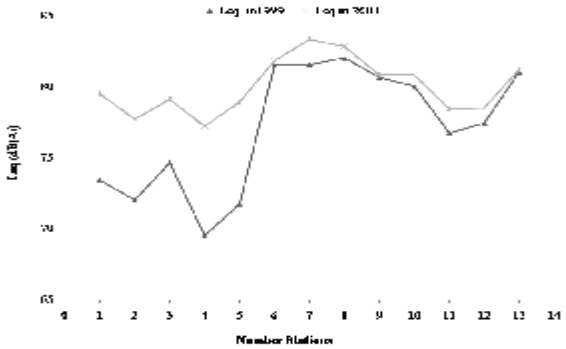

Fig. 1: Equivalent noise level (L_{eq}) at 13 stations in 1999 and 2008

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

Station Number	L_{99}	L_{90}	L_{50}	L_{10}	L_{Min}	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

	Saturday		Tuesday		Friday		Average		Total
	Light	Heavy	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}	82.15±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±2.5

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 of 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_{eq}) 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 L_{eq} 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_{eq} was equal to 79 dB (A) with 71.4 dB (A) the lowest amount of L_{eq} (25). In another study in 2006 in the south of Tehran (capital of Iran) L_{eq} was equal to 78.5 dB(A) (26). The highest L_{eq} average in a study in Mashhad (Iran) in 2003 was equal to 78.5 dB(A) (27). In Sari (Iran) in 2007, the L_{eq} average was equal to 77.1 dB (A) and minimum and maximum level of L_{eq} recorded 62 and 92.3 5 dB(A) respectively (28). The L_{eq} 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_{eq} was 81.7±1.4 dB(A) and the L_{eq} average was 79.7± 2.6 dB(A) (higher than Kerman)(29).

In a study conducted in Asansol, India the L_{eq} values have been reported 51.2 to 89 dB (A) (30). In another study in Alexandria (Egypt) the L_{eq} values were between 74.2 and 83.7 dB (A) (31). In both cases, the L_{eq} 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_{eq} was 74.7 dB (A) (32). Average daily values of L_{eq} in 2005 were 77.2 ± 4.6 in Belgrade (Serbia) (33). Overall, the L_{eq} 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.

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