Road traffic noise, annoyance and community health survey - A case study for an Indian city

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Abstract

The present study is aimed to investigate the impact of noise pollution on residents/community residing near roadside. The degree of annoyance was assessed by means of a questionnaire. It was found that among all noise-generating sources, road traffic was the major source of noise followed by factory/machines. A health survey reported about 52% of population was suffering by frequent irritation. 46% respondent felt hypertension, and 48.6% observed loss of sleep due to noise pollution. Common noise descriptors were also recorded at all the selected sites. It was found that the Leq values were higher (range 73-86) compared to the permissible values (65 dBA) prescribed by the Central Pollution Control Board, New Delhi. Further, regression equations were developed between various noise indices and percentage of population highly annoyed, and a strong correlation was also observed.

Keywords: Interrupted road traffic, mean dissatisfaction score, noise annoyance index, noise indices

Introduction

Noise is an undesirable sound emanated from different sources.[1] Evidences indicated that it may have an adverse impact on human health.[2,3] It is a feeling of displeasure, irritation, or disturbance, which directly cause 'immediate effects' including sleep, mental concentration, and aural communication disturbances and also gives a negative effect on community or individual.[4-6] Zannin *et al.*,[7] reported that long term noise-related health hazards can cause permanent hearing loss among exposed individuals. Furthermore, exposure of high level noise can cause severe stress on auditory and nervous system of human beings.[8,9] It was found that annoyance increases with the intensity of sound. High frequency noise is more irritating and disturbing compared to the low frequency noise.[10] A majority of studies has been concerned with the subjective responses to noise, given different names like annoyance, dissatisfaction, nuisance, and sensitivity.[11] Nivison and Enderson [12] (1993) referred to annoyance as a perception of individual and reaction to a stimulus. A number of social surveys have been conducted to assess the community response to environmental noise since 1960s. Most studies were focused on the development of annoyance curves with single noise sources, which stand for the reaction of people living in a nation or a cultural area.[13] To estimate the noise annoyance, a five-point scale was generated by Fields *et al.*[14] International Commission on the Biological Effects of Noise (ICBEN) has recommended guidelines for investigating the community response, noise survey, and its effects on community. This includes the overall survey design, social survey samples, social survey data collection, and nominal acoustical conditions.[15] Abdel *et al.*,[16] investigated that road traffic is the major source of annoyance in developing countries. They found that in Asian countries, rather limited knowledge is available from published surveys on road traffic noise status and its influences on the community.

In India, the traffic mix is usually heterogeneous and conditions of traffic jams and interruption are very frequent. Further, heavy traffic volumes, higher speeds, and greater number of trucks and buses also increase the loudness of traffic noise. Improper stoppage of buses at locations rather than desired bus stoppage also cause traffic jams on roads. Besides, as the roads are narrower and different types of road vehicles are not plying separately in the road lanes, it creates deceleration and acceleration noises as vehicles approach and depart from each other.[17]

Jaipur is one of the most important heritage cities, reflecting the traditional and modern culture of the western region of India. The older city was developed by the king, while the outer city has been expended by the Jaipur Development Authority. The city has not been designed as per future

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requirements. Therefore, the commercial, industrial, and residential sites have not been separated independently. It increased the mixed traffic load at all the selected locations. Further, the public and private transportation systems are available in the city, but they are not able to cover the regions of the city, as the city has not been expanded as per master plan. It has developed the tendency to have personalized modes among residents of the city. The annual growth rate of the motorized vehicles shows an increasing trend in the past ten years (1999-2008) as shown in Figure 1.

The present study is based on a social survey to investigate the people's perception towards noise annoyance and health effects. Further, the study gives quantitative criteria to link the noise exposure with annoyance levels of the exposed individuals. For this, the noise exposure descriptors i.e., day-night average sound level (Ldn) is estimated, which is one of the general techniques to evaluate the annoyance in terms of an index. The noise pollution level (Lnp) represents the increase of annoyance caused by fluctuations in noise during time intervals. It is a good indicator of pollution in the environment for both physiological and psychological disturbances of human system as it accounts the variations in the sound signals. One another unit, traffic noise index (TNI) has also been measured, which represents the range over which the sound level is fluctuating in an interval of time.[18] All these parameters were correlated with the psychological term "highly annoyed," represents the response of a social survey question on noise annoyance with in top 27% to 29% on a numerical scale for investigating the relationship between annoyance level and different noise indicators.

Monitoring of noise data and health opinion survey

In the present study, a detailed social survey was carried at highly busy, ten commercial –industrial road stretches, having medium to heavy traffic flow, and covering major intersection points of the city. All study locations had heterogeneous traffic flow. It included all categories of vehicles such as two-wheelers, three-wheelers, cars, jeeps, mini buses, full-sized buses, hand driven carts, hand driven cycle rickshaws, trucks etc. Indeed, the multiple modes of transportation were continuously plying on the roads; however, the number of two wheelers was very high among all the categories of vehicles at the selected study locations. Beside this, the roads were overcrowded and were not perfectly designed, which resulted in the deviation to follow the traffic lane system by the drivers. It directly influenced the traffic congestion and honking behavior of drivers. The traffic volume was assessed in terms of Passenger Car Units (PCU). It is the scale to convert all vehicles into one category, i.e., passenger car. The PCU values for two wheelers, three wheelers, light commercial vehicles, buses, and heavy commercial vehicles are 0.75, 2, 2.5, 3 and 3, respectively.[19] Similarly, the traffic speed was also recorded by Doppler speedometer at all the identified locations. It was highly influenced by the regular traffic interruptions. The traffic speed was also recorded for all types of vehicles at all the study points. The average traffic speed was measured in kmph. Table 1 shows the traffic characteristics, average traffic volume in terms of PCU and average traffic speed for all the selected locations. The present study was aimed to investigate the quantitative estimation of noise annoyance and its health effects among individual residents. A total of 550 people were interviewed and 45-65 were selected at each of the selected locations. A detailed noise social survey was conducted to know the opinion of the exposed individuals about how the noise is affecting their daily life. A comprehensive literature was studied to develop the survey questionnaire.[20-22] The first part of the questionnaire was related to the personal information of the respondents such as age, sex, occupation, income, and the time period in their present house. The second part covered major sources of noise pollution at all the selected locations. For this, all types of noise creating sources like road vehicles, factories, construction work, trains, television, social activities, and religious places etc were incorporated in the questionnaire. Each respondent was asked to reply five-verbal questions ranging from not affected to the extremely affected by the individual types of noise-generating sources. The third part of the questionnaire was related to the health effects of noise on individual residents affected by noise pollution. The health-related questionnaire covered the daily life problems. All respondents were asked to respond to the questions, i.e., with respect to the yes, no, or don't know, respectively. To estimate the level of noise annoyance and its effects on individuals, all data regarding reactions of individual were recorded and clubbed together to find a mean value of annoyance at all the selected locations. To correlate the non-audiometric impact (annoyance) with different noise indices, various noise parameters, i.e., Leq, TNI, Lnp, and Ldn were calculated. To calculate the common noise indices, Sound Level Meter SC-30 (version 1.0-2.1) having digital display was mounted on a stand at a height of 1.2 m above the ground level with 7.5 m distance from the centre line of the road. The noise data were taken at the pre-selected study locations at which the traffic data and noise social survey

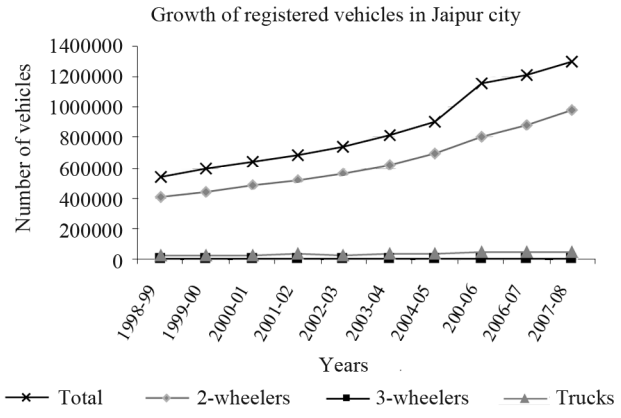

Figure 1: Growth trends of registered vehicles in Jaipur city

were carried out. The traffic volume and noise monitoring were noted for 24 hours as presented in Table 1. Further, to find out the relationship between various noise descriptors and annoyance levels, a set of linear regression equations were generated.

Analysis of health survey data

Table 2 shows the basic socio-demographic characteristics of the studied population. It was found that among all participants, males were varying from 35 to 56%, whereas females from 44 to 64% at all the ten sites. The ages of interviewed persons were ranging 15-25 years (25%), 25-45 years (35%), 45-65 years (30%), and 65 years (10%), respectively. It was found that about 24% people were living about <5 years in their current houses. While 59% people were living about 5-15 years in their current houses. About 17% people were living for more than 15 years in their houses. Figure 2 shows that among all the major noise creating sources, road traffic was the major source at all the selected locations. It was ranging between 65-85% at all the identified road stretches. Table 3 shows the psychological disturbances found in noisy area. It was found that 52% sample population among males reported frequent irritation due to traffic noise exposure. Headache was reported by 67.3% among males as a result of exposure to traffic noise, and 48.6% believed that traffic noise could cause loss of sleep. About 46% respondents felt hypertension and 34.7% suffered stress during work. While 77.1% females were disturbed due to the noise-generated problems, it was found that 64% females were suffering severe irritation problems. About 85% female interviewers complained of headache, which was created by different noise-generating sources. While 78.3% were unable to sleep because of noise, 55.4% felt stress in their day-to-day life. It was investigated that the female respondents were more sensitive towards noise related-health problems. The reason perhaps that, in India, the numbers of housewives are higher than the working class females and due to continuously living in a particular surroundings they have to face noise-related problems daily.

It was observed that the value of Leq ranged between 73-84 dBA for most of the selected locations. It crossed the standard permissible limits of 65 dBA for commercial locations set by the Central Pollution Control Board, Delhi, India. While the TNI ranged varied between 73 and 88 dBA. It was observed that at some locations the characteristics of noise caused by fast moving traffic, different from those caused by congested or slow moving traffic. Noise from

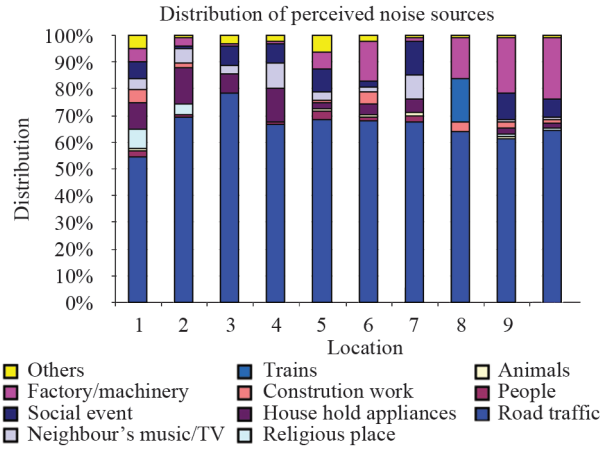

Figure 2: The dominant source of noise pollution at all the selected locations

Table 1: General features of all selected locations

Name of the locations	Nature of land use	Traffic characteristics	Dominance of road vehicles	Road condition	Traffic density in terms of PCU	Average traffic speed in kmph	No of lanes
Polovictory near bus station	Commercial	Heavy traffic flow with traffic jams	Two wheelers, three wheelers, four wheelers	Narrow and overcrowded	1613.98	14.520	4
Gopal pura by pass road	Commercial	Heavy, congested	Two wheelers, trucks	Narrow and overcrowded	21918.02	18.71	4
Youth hostel	Commercial	Heavy, frequently congested	Cars, two-wheelers	Broad and maintained but overcrowded	258926.5	19.91	6
Birla mandir near JDA circle	Commercial-Institutional	Heavy, free flow	Two-wheelers, cars	Broad and maintained	470457.1	21.20	6
Khasa kothi petrolpump circle	Commercial	Medium	Cars	Narrow	122222.2	23.83	4
Panipaich	Commercial	Heavy, congested	Buses, two-wheelers	Narrow, poorly maintained	688803.31	24.9	4
Queen's road circle near Vaishali nagar	Commercial	Medium, Free flow	Not a particular type of vehicle is in dominance	Broad and fully maintained	137845.2	27.46	4
Jaipur Junction	Commercial	Heavy, congested	Three wheelers, cars	Narrow and poorly maintained	472442.8	26.66	4
Sodala thana circle	Commercial-Institutional	Heavy with frequent traffic jams	Two wheelers, bicycles	Narrow and poorly maintained	241559.6	28.86	4
Tranport nagar near NH-8	Commercial	Heavy with frequent traffic congestion	Trucks	Narrow and poorly maintained	211436.9	16.48	6

Table 2: Basic socio-demographic characteristics of the studied population

Factors	Percentage of different factors at all the selected locations; represented by L1, L2, L3…etc									
	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10
Sex										
Male	50	40	45	50	46	48	35	37	56	39
Female	50	60	55	50	54	52	65	63	44	61
Age (Years)										
15-25	39	33	24	12	26	24	37	34	20	17
25-45	32	32	62	43	44	28	49	21	32	25
45-65	19	23	01	28	23	29	12	34	43	37
>65	10	12	13	17	07	19	02	11	05	21
Occupation										
Service	21	27	67	69	30	32	74	35	36	23
Business	31	36	26	23	67	48	13	19	55	68
Others	48	37	07	08	03	20	13	64	08	08
Gross Salary (Rs. per month)										
>5000	53	35	23	12	46	44	22	26	32	36
5000-15000	25	55	68	72	27	35	63	55	41	49
<15000	17	12	19	08	16	27	21	15	27	15
Education										
>Secondary	28	42	18	28	31	30	40	04	31	56
Secondary	39	23	14	16	25	19	27	29	36	16
<Secondary	33	35	68	56	44	51	33	67	33	28
Time period in the current house (in years)										
>5	22	26	23	28	23	25	21	25	20	27
5-15	56	62	58	53	64	65	51	66	48	68
<15	22	12	19	19	13	10	28	08	42	03

L – Selected location

Table 3: Distribution of sample individuals responses with respect to the health impacts of traffic noise at all the selected locations

Health factor	Male (%)			Female (%)		
	Yes	No	Don't know	Yes	No	Don't know
No disturbance	18.5	65.8	15.7	10.7	77.1	12.2
Irritation	52	35	13	64	27	09
Headache	67.3	15.8	16.9	85	10	05
Hypertension	46	48.9	5.1	54	31	15
Loss of Sleep	48.6	35.2	16.2	78.3	8.3	13.4
Stress	34.7	38.5	26.8	55.4	28	16.6

congested traffic was found to contain occasional peaks and vary more in levels. The average Ldn was in the interval of 70-84 dBA. It indicates high fluctuation and disorder less conditions on roads, which develops tendency to blow horn among drivers.

Figures 3 shows the XY scatter plots for one of the noise annoyance descriptors i.e., Lnp out of all other descriptors. Table 4 shows the regression equations for all the calculated parameters. Although it was found that the R^2 was in in the range of 0.55-0.77 for all the parameters, it predicts that as the different noise parameters increases, the annoyance level among people also increases, which directly affects the health of the individual person and the whole environment as well.

Table 4: Combined regression equations of various noise descriptors for the whole city

Parameter	Slope	Intercept	Regression coefficient
Leq	1.30	–37.88	0.67
TNI	0.90	–32.02	0.58
Ldn	0.87	–37.21	0.77
Lnp	0.92	–32.10	0.55

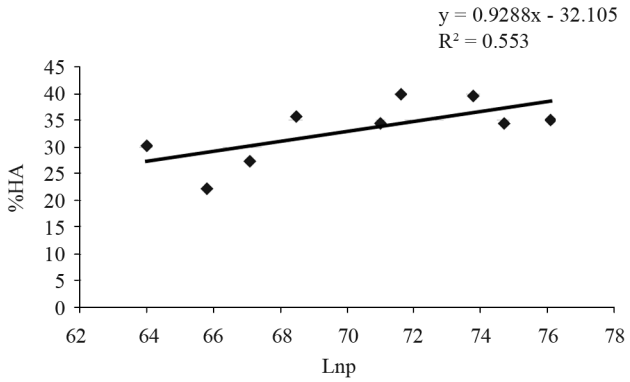

Figure 3: Lnp and %HA

Conclusions

As noise is directly or indirectly affects the human health, a detailed social survey was carried out to investigate the ill effects of noise on exposed individuals. It was found that 60-85% people opined that vehicular road traffic was major source of noise pollution and creates annoyance among people. About 52% sample population reported frequent irritation, while 67% people were suffering by common noise-related problem like headache or loss of sleep. Further, the present study highlighted the relationship between attitudinal responses of the individual person and different noise indices. It indicated that the noise annoyance (psychological term) can correlate with different mathematical noise parameters. It was observed that all parameters were directly proportional to the Percentage highly annoyed (%HA). It indicated that in a medium class city like Jaipur, as the noise levels increases the level of annoyance also increases.

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