AUDIOMETRIC ASSESSMENT OF URBAN ROAD TRAFFIC NOISE AFFECTED PERSONS: A CASE STUDY OF SURAT, INDIA

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ABSTRACT

Among all of the sources responsible for noise pollution, traffic related sources are of great environmental concern and increasing level of discomfort in urban areas with increasing traffic concentration. It will be a larger and serious problem in the future, if effective precautions are not taken addressed and attended to. Hence, a study was undertaken to measure the levels of road traffic noise at major intersections of Surat city, located in Western India and assess the hearing impairment among the exposed group of population. Manual noise measurements and vehicle counts were performed at three of the busiest traffic intersections in the city for a period of 12 hours. Audiometric screening was done on 46 urban road traffic noise affected persons, working or staying at these intersections to determine the occurrence of hearing impairment.

At all the three intersections, Leq measured was well above the permissible levels of 65 dBA for daytime. The Lmax recorded for three intersections were 84.6 dBA (07:36 PM), 87.3 dBA (06:32 PM) and 85.6 dBA (11:41 AM). Audiometric screening showed that only 10 persons (22%) had normal hearing. slight, moderate and severe hearing impairment was recorded among 13 (28%), 18 (39%) and 5 (11%) persons respectively. Of the total 46 participants, none had profound impairment (deafness, hearing loss > 81 dB). Of the remaining 36 having hearing impairment, 27 had bilateral impairment.

Keywords: Road traffic noise, noise affected persons (NAP), audiograms, hearing impairment.

1. INTRODUCTION

Though technological advance has brought many conveniences, it has also resulted in many hazards. Pollution of various types is one of them. These include air pollution, water pollution, soil pollution, thermal pollution and noise pollution (***Rahmani et al, 2011***). The peace of countryside and the sounds of jungle have been shattered, perhaps forever, by the internal combustion engine, both on the ground and overhead. Inside our homes, power gadgets and outside our homes, powerful vehicles surround us, each is a source of noise pollution.

In the early times, noise was limited to the work places like industries and construction sites. But today, the profile of noise source has changed with music / entertainment in indoor environment and transportation in outdoors making a major contribution. Among all of the sources responsible for noise pollution, traffic related sources are of great environmental concern and increasing level of discomfort in urban areas with increasing traffic concentration (***Fadel et al, 2002***). It will be a larger and serious problem in the future, if effective precautions are not addressed and attended to.

2. LITERATURE REVIEW

A study in India reports that Delhi, Calcutta, Bombay and Bangalore are noisiest cities due to traffic (BBC World South Asia report, 1999). Health effects of noise include both the auditory as well as non-auditory effects. Some of the major non-auditory hazards caused by the noise are annoyance, disturbance to sleeping, reading, speech communication, concentration of mental work, whereas the occupational hearing loss due to noise includes acoustic traumatic injury and noise induced hearing loss.

Prolonged exposure to high intensity noise can damage and destroy sensory hair cells of the inner ear leading to irreversible hearing loss (***Lusk, 1999***). Noise induced hearing loss (NIHL) is the second most common form of acquired hearing loss after age related hearing loss (prebycusis), with studies showing that people who are exposed to noise levels higher than 85 dB suffered from NIHL (***Rabinowitz et al, 2005; Omokhodion et al, 2008***)

A typical NIHL, of a sensory neural type, is generally bilateral and symmetrical, usually affecting the higher frequencies (3k, 4k or 6k Hz) and then spreading to the lower frequencies (0.5k, 1k or 2k Hz) (***Nandi & Dhatrak, 2008***). In NIHL, the auditory sensory cells, once damaged, cannot repair themselves nor can the medical procedures restore normal functioning. The risk of hearing loss and injury to the ears increases with the sound intensity, the length of time a person is exposed to noise and the individual susceptibility to NIHL.

Noise surveys in developing cities like Surat and many other Indian cities suggest that noise load is much higher than in Western countries (***Rao & Rao 1991; Chakraborty et al 2002; Nirjar et al 2003; Parbat and Nagarnaik 2007; Agrawal and Swami, 2011***). However, there is little documentation about the prevalence of hearing impairment due to traffic noise for India (***Deepak 1997; Ingle et al, 2005; SAHI 2008***).

3. OBJECTIVES

The major objective of the study is to assess road traffic noise at three major intersections of Surat city and report the hearing impairment among urban road traffic noise affected persons (URT-NAP).

4. STUDY AREA PROFILE

The study was conducted at three different intersections of Surat city on Ring Road, namely Athwa Gate, Udhna Darwaja and Sahara Darwaja.. Surat is referred to as the commercial capital of Gujarat state. Surat is the fastest growing city in India. In 1991, 2001 and 2011, the populations were 1.498, 2.433 and 4.624 million respectively. The last decade has experienced an unprecedented growth. An inconceivable growth rate of 76.02 % was observed in the last decade as a result of rapid industrialization (see Fig. 1). Owing to population explosion and rapid industrialization, transportation in the city reached to unimaginary heights, with the vehicles registered at Regional Transport Office, Surat being 1.5 million plus (see Fig. 2) These made traffic congestion problems complicated leading to an exponential increase in noise pollution.

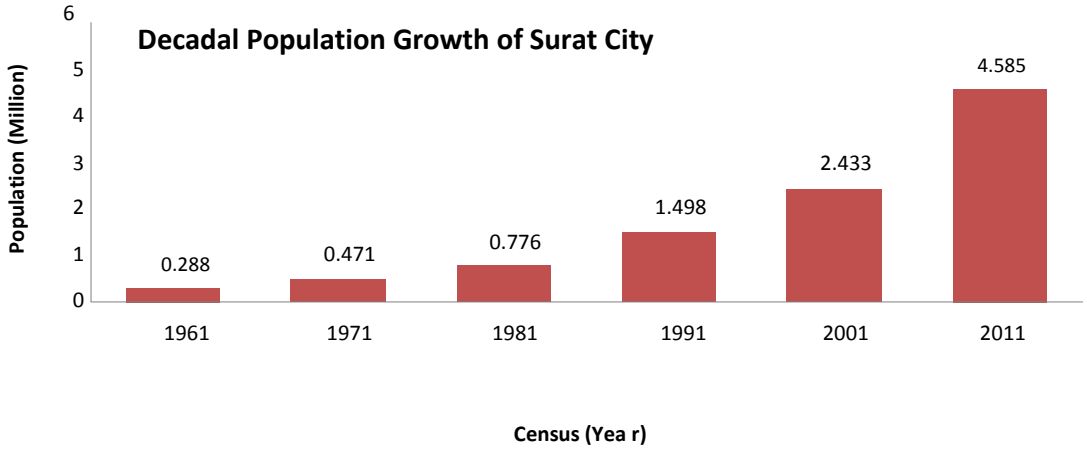

Figure 1: Decadal population growth of Surat city

Car ownership per 1000 persons increases every year. In 2011, it is 35 cars per 1000 population, which was only 22 cars per 1000 before a decade, Increasing car ownership has resulted in higher traffic congestion. Lack of needed mass transportation has further created more concentration of personalized and para-transit mode of transportation, reducing the effective road capacities.

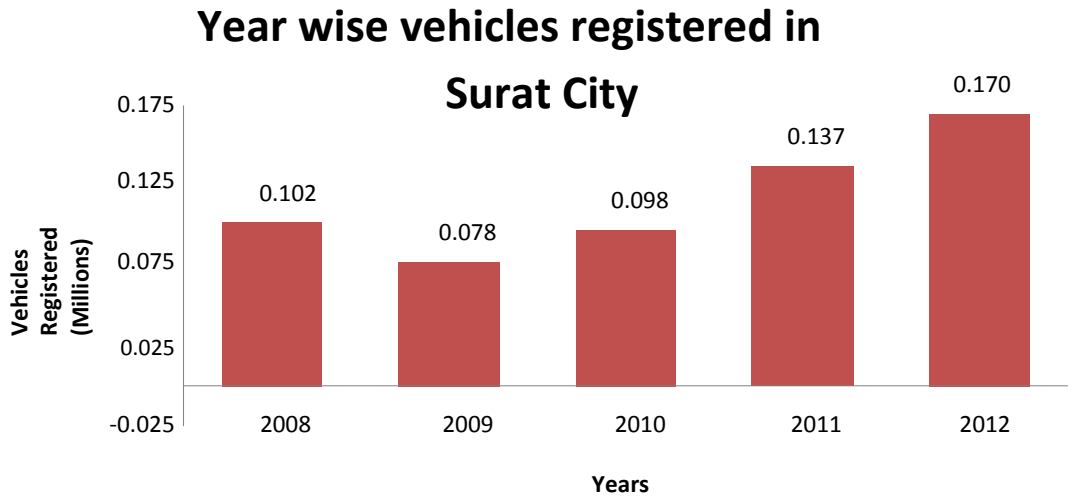

Figure 2: Vehicular growth of Surat city

5. MATERIALS AND METHOD

Noise measurements were done using a Larson Davis System UTI 824 integrated sound level meter. The meter was set for A weighting and all the readings were taken at a height of 1.2 m above the ground level. Measurements were done during the 12 hour period of 9:00 am to 9:00 pm, with a L_{eq} reading noted manually every minute in the data sheet. Care was taken to ensure that the sampling location chosen represent the urban road traffic noise affected persons.

Out of the 12 hour duty time, the traffic policemen receive atleast 10 hour per day of heavy doses of vehicular noise pollution. Forty six traffic policemen were selected from three busiest intersections of Surat city for audiometric testing, their age ranging between 31 to 55 years. This was done to avoid participants having age induced hearing loss. The subjects were not exposed to traffic noise 12 hours before the audiometric testing, to avoid the temporary threshold shift (TTS). Prior to going for audiometric test, the subjects must satisfy an octoscope examination to check the inner and outer part

of the ear under the supervision of an ENT specialized doctor. Before being eligible for audiometric test, they must be free from any injury to external ear canal and ear drum, absence of ear wax, no family history of hearing loss before the age of 50.

Audiometric testing was carried out in a sound proof room. Pure tone air conduction audiometry with a diagnostic audiometer was carried out. Hearing thresholds were measured at frequencies 250, 500, 1000, 2000, 4000 and 8000 Hz. Although several methods exist to calculate hearing impairment (%), the most commonly adopted one (American Academy of Otolaryngology, 1979) is as follows:

(i) From the audiogram, calculate the average of the thresholds of hearing for frequencies of 500, 1000, 2000 and 4000 Hz.
(ii) Deduct from it 25 dB (hearing threshold level).
(iii) Multiply it by 1.5 (increase of 1.5% for each decibel loss above 25dB).

This is the percentage (%) of hearing impairment for that ear. Similarly, calculate the percentage (%) of hearing impairment for the other ear. The % hearing impairment of an individual is calculated using the formula given below (***Niland, 1994***)

$$\% \text{ impairment of an individual} = \frac{(\text{Better ear\% X } 5) + (\text{Worse ear\% X } 1)}{6}$$

Hearing impairment was categorized into slight, >25-40 dB, moderate, 41-60 dB, severe, 61 to 80 dB and profound (deafness), > 81 dB as recommended by World Health Organization (***WHO 1991***).

6. RESULTS AND DISCUSSION

The study was conducted at three busiest intersections of Surat city on Ring Road, namely Udhna Darwaja, Sahara Darwaja and Athwa Gate (see Fig. 3).

There are three major arterial roads (corridors) in Surat city. These corridors are (i) Udhna-Sachin corridor (ii) Sahara-Kadodara corridor (iii) Athwa-Dumas corridors. These arterial roads (corridors) include diversified activities of business, residence, commerce and industries. Different type of land-use pattern is seen along these arterial roads / corridors. These three arterial roads (corridors) are the entry-exit of Surat city and they start from Udhna Darwaja, Sahara Darwaja and Athwa Gate intersections respectively. A heavy and mix type of traffic has been observed on these intersections and due to these reasons, these three intersections were selected for the study purpose.

Figure 3: Map of Surat city showing study area

Results of traffic noise survey at three major and busiest intersections is presented in

Table1. Table 1: Noise level at intersections

Sr. No	Intersection	Lmax (dBA) (Time)	Lmin (dBA) Time	Leq (dBA) ± SD
(1)	Athwa Gate	79.2 (7:36 pm) (10:48 am)	74.0 (3:13 pm)	77.57 ± 8.30
(2)	Udhna Darwaja	84.4 (6:32 pm)	78.4 (9:11 am)	81.36 ± 6.10
(3)	Sahara Darwaja	84.7 (6:44 pm)	76.8 (9:04 am)	81.83 ± 6.30

In traffic environment at all three intersections, noise levels, L_{max}, L_{min} and L_{eq}, measured were always higher than the permissible norms (Central Pollution Control Board, 2000) of 65 dBA.

Audiograms were done for 46 traffic policemen, aged between 31-55 years, mean 46.4 ± 6.54 years. A total of 10 traffic policemen, 22%, had normal hearing in both ears. As such, the prevalence of hearing impairment in either or both the ears was 36 (78%), which can be said to be very high when compared to other occupations. 9 participants (19.6%) had hearing impairment in one ear and 27 (58.4%) had bilateral impairment. Among the traffic policemen with hearing impairment, major of them (67%) had an average threshold in the 26-60 dB range i.e. slight (26-40 dB) to moderate (41-60 dB) hearing impairment. The prevalence of hearing loss in left and right ears is shown in Table 2.

Table 2: Hearing impairment among noise affected persons (NAP) (N=46)

Ear reported	Normal hearing (<25 dB)	Slight hearing impairment (26-40 dB)	Moderate hearing impairment (41-60 dB)	Severe hearing impairment (61-80 dB)
Left ear	13 (28.3%)	14 (30.4%)	15 (32.6%)	4 (8.7%)
Right ear	15 (32.6%)	13 (28.3%)	17 (36.9%)	1 (2.22%)

Table 3: Mean age of noise affected persons (NAP) (N-46)

Hearing impairment (N)	Mean age Years ± SD
Normal hearing (10)	36.7 ± 8.9
Unilateral hearing impairment (9)	44.2 ± 10.1
Bilateral hearing impairment (27)	52.3 ± 11.2

7. CONCLUSION

In traffic environment, at all three intersections i.e. Athwagate, Udhna Darwaja & Sahara Darwaja the noise levels, L_{eq}, measured were always higher than the permissible level of 65 dBA. The people affected by this noise level are mainly traffic policemen, about 10 hours a day and 7 days a week.

Audiological assessment of 46 traffic policemen revealed a high prevalence of hearing impairment in either or both the ears, 36 (78%), which can be said to be very high when compared to other occupations. Among the traffic policemen with hearing impairment, major of them (67%) had an average threshold in the 26-60 dB range i.e. slight (26-40 dB) to moderate (41-60 dB) hearing impairment. The prevalence of hearing loss in either ear increased with age.

As the study is limited to a small number of participants (N=46), for whom audiometric assessment was conducted, a direct quantification of noise exposure for each participant (traffic policeman) is not possible. However, traffic noise is the major cause of hearing impairment among them.

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