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EVALUATION OF AUDITORY ACUITY IN CROSS-SECTIONAL POPULATION OF BANGALORE CITY

Irshad Ahamed[1], Shaikh Mohsin[2]

[1]Department of Physiology, KMCT Medical College, Calicut, Kerala
[2]Department of Preventive and Social Medicine, Government Medical College Baroda, Vadodara, Gujarat

E-mail of corresponding author: irshadahameddr@gmail.com

ABSTRACT

Background and Objectives: Noise pollution in urban city like Bangalore is a serious problem and steadily increasing over the years. The relationship between noise exposure and hearing loss in normal subjects residing in urban city like Bangalore is yet to be investigated. The aim of this study was to evaluate the auditory acuity in cross-sectional population of Bangalore city. **Methods**: 219 normal subjects residing in noisy roads in four geographical areas belonged to test group and 52 normal subjects residing in silent area belonged to control group were subjected to a pure tone audiometric assessment. The resulting data was statistically analyzed with SPSS software. **Results**: The auditory thresholds in most of subjects residing in noisy areas were higher at the frequencies 1000, 1500, 2000, 3000, 4000, 6000 and 8000 Hz in both ears when compared with subjects residing in residential area. This was suggestive of increase prevalence of sensorineural hearing loss among subjects of noisy area. **Conclusion**: Subjects residing in noisy areas have an increased risk of noise induced hearing loss. The duration of exposure to noise had a direct effect on degree of hearing impairment in subjects of noisy area.

Key words: audiometry, hearing loss, noise

INTRODUCTION

Development in technology, commerce, communication and education has enhanced the urban growth both in developed and developing countries[1]. There have occurred many environmental problems in the city like Bangalore with increased urbanization and noise has emerged as one of major environmental problems. Noise can be defined as any unwanted, disturbing or harmful sound that impairs or interferes with hearing, causing stress and hampers concentration[2]. Noise pollution emanates from both outdoor and indoor environment and major contribution to outdoor noise often comes from road transportation which is the main source of pollution. Noise survey in various cities throughout the world has revealed that traffic noise is typically the largest contributor to recorded sound levels and the most important source of annoyance[2]. Of the more than 28 million Americans with some degree of hearing impairment, as many as 10 million have hearing loss caused in part by excessive noise exposure[3]. The noise levels in Mumbai vary between 75-90 decibels that peaks to 100 dB during festive seasons and in Kolkata the noise levels reaches above 100 dB at busy streets[4].

A recent study by Mysore based All India institute of speech and hearing (AIISH) has found that noise levels in all major roads in Bangalore city are over 80 dB while permissible levels are only 65 dB[5]. It has been well established that exposure to traffic noise causes annoyance, hearing loss, mental disorders and adverse physiological and psychological impacts. The situation of Bangalore due to rapid urbanization needs to be investigated, which may be one of the precipitating factors of increased stress related disorders. Diagnostic audiometry comprises of tests which detect conductive and sensorineural hearing loss. Pure tone audiometry involves the estimation of threshold of hearing for certain standardized stimuli via the air and bone conduction routes[6]. An audiometer, being a fundamental tool in the diagnosis of auditory capacities has been employed to evaluate auditory acuity in cross sectional population in different areas of Bangalore city.

MATERIALS AND METHODS

The study was conducted in a sample of 271 normal subjects after informed, written and verbal consent in Bangalore between April to September 2006. They were divided into two groups. Group 1comprises of 219 normal subjects working in noisy roads in four geographical areas (West, North, South and East). The West, North, South and East area was recognized as Noisy area No. 1, 2, 3 and 4 respectively which include 56, 56, 54 and 53 subjects respectively. The selection of subjects was based on fact that they were staying in different noisy areas (exposed to traffic noise for 8 hours/day or more for duration of 10 years or more). This group includes street-vendors, shopkeeper of the roadside, traffic policemen, drivers and conductors of Bangalore Metropolitan Transport Corporation (BMTC). Group 2 comprises of 52 normal subjects which was relatively silent when compared with above four areas. This area was recognized as Residential area. The selection of subjects was based on fact that they were staying in specific residential areas for 8 hours/day or more for duration of 10 years or more. This group includes house wives, shop keepers of this area. The selection of subjects is based on inclusion-exclusion criteria. Inclusion criteria includes age group between 20 to 50 yrs and subjects who are staying in selected noisy and silent areas for at least ten years while the patients suffering from hypertensive, Diabetes or patients using ototoxic drugs since last 3 months or having history of ear surgeries or recent ear, nose, throat infection were excluded.

The Pure Tone Audiometry (PTA) was conducted on all subjects with the help of audiometer and results were noted. The selected subject was required to answer a detailed questionnaire exploring their hearing status[7]. He was also subjected to an otological examination to rule out any external and middle ear pathologies. A detailed general physical and systemic examination is done on the subject and he is taken to the sound proof room for an audiometric testing. The method is based on American Society for Speech and Hearing Association [ASHA] 1978 guidelines for PTA. Masking (Masking PTA) is done to mask the ear not under test and when the air bone gap of the poorer ear under test is more than 10 dB[8].

Interpretation of an audiogram suggests three types of deafness [7]. Conductive deafness is indicated by raised air conduction thresholds (>25 dB) and a normal bone conduction threshold with a wide air- bone gap of 15 dB or more. Sensorineural deafness is indicated by raised air and bone conduction thresholds (both >25 dB) and the air bone gap does not exceed 10 dB, while Mixed deafness is indicated by air and bone conduction thresholds was raised (both >25 dB) with an air bone gap of greater than 15 dB. Degree of hearing loss was noted as per WHO classification[8]. Data were analysed using SPSS software

RESULTS

In the present study, there are two groups of subjects, one group consisting of 219 normal subjects residing in noisy roads in four geographical areas (west, north, south, east) and other group consisting of 52 normal subjects staying in relatively silent (residential area).

Table no. 2 to 7 shows the results of the subjects working in noisy i.e. the test group and the subjects residing in residential area i.e. the control group. It was prepared and rearranged as per requirement of the parameters discussed. It is important to first appreciate that the noise levels in urban city of Bangalore are above 80 dB in all major roads which is above permissible levels[5]. The actual effect of noise on auditory acuity of normal subjects residing in noisy roads is unknown. In this study, the test group (subjects belonging to noisy area 1, 2, 3, 4) and control group (subjects belonging to residential area) have been selected and matched with respect to age (table1), to remove the effect of presbycusis[9]. It is of prime importance to appreciate that noise induced hearing loss develops gradually and noise can cause permanent hearing loss at chronic exposure of 85 dB or higher for an eight hour period[3]. It is said that 10 years or more of exposure is generally required for significant hearing loss to occur. Hence in present study only those subjects from both control (residential area) and test group (noisy area) were selected who were staying in the respective area for a minimum of 10 years and exposed to noise for a period of 8 hrs/day.

It is evident from tables 2 to 5 that the auditory thresholds of subjects residing in the noisy roads are above 25 dB at frequency 1000 to 8000 Hz and increase in threshold progresses through frequencies 1000 to 6000 Hz reaching maximum level at 4000 Hz and relatively lower at 8000 Hz, when we compare the hearing thresholds of the subjects in each noisy area (1 to 4) versus residential area (5) ($P<0.05$). Table 6 and graph1(right ear); Table7 and graph 2(left ear) indicates the number of subjects having auditory thresholds more than 25 db in right and left ear residing in noisy area (1 to 4) and residential area(1). It shows 60% of subjects having abnormal audiograms in noisy area whereas in residential area group, it is 10% (Table 6 and 7). These results of present study are in accordance with studies carried by Patwardhan et al[10], Lee LT[11].

The noise induced hearing loss begins with selective loss of hearing at around 4000 Hz, with thresholds better at both higher and lower frequencies. This is recognized on an audiogram as a notch centered around 4000 Hz. If exposure is continued, the notch gradually deepens and widens, eventually retention of good hearing in the higher frequencies is lost and the resulting hearing loss appears only as a relatively steep high frequency loss at 3000 Hz and becoming more severe at each higher frequency over a period of many years. Persistent noise exposure progressively encroaches on middle frequencies and in most severe cases, even the lower frequencies may become involved[10].

CONCLUSION

In this study, the auditory acuity of normal subjects residing in noisy area and residential area were studied and it showed that exposure to noise raises the auditory threshold in frequencies between 1000 to 8000 Hz in the age group of the people selected for this research. The auditory thresholds were mostly affected in higher frequency range with highest threshold at 4000 Hz and relatively lower at 1000 and 8000 Hz. The auditory thresholds were almost similar in both the ears signifying sensorineural hearing loss. The results which show the effect of noise on auditory acuity may be explained by mechanical trauma on hair cells and metabolic exhaustion.

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Table 1: Age distribution of subjects in different areas

Population	Number of subjects	Mean ± SD
Area 1	56	43.64±6.06
Area 2	56	42.21±7.76
Area 3	54	41.76±7.78
Area 4	53	42.91±8.38
Area 5	52	40.12±6.87
Inference	Samples are age matched (P>0.05)	

The subjects of all four noisy areas and the residential area are age matched.

Table 2: Comparison of mean auditory thresholds in right & left ear of subjects residing in Noisy area 1 and residential area:

	Right Ear					Left Ear				
Frequency (Hz)	Noisy Area 1		Residential area		P value	Noisy Area 1		Residential area		P value
	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
250	13.75	5.16	14.42	5.48	0.656	11.61	4.48	13.27	4.19	0.182
500	15.98	4.09	16.25	3.95	0.814	15.09	3.37	16.06	3.48	0.322
1000	19.46	6.23	13.94	3.88	<0.001**	18.39	5.32	12.98	4.11	<0.001**
1500	21.79	10.97	9.71	6.45	<0.001**	21.79	10.68	8.37	7.59	<0.001**
2000	24.11	16.49	5.19	9.60	<0.001**	24.02	16.72	5.38	10.19	<0.001**
3000	26.79	19.48	7.60	10.17	<0.001**	27.50	20.36	7.88	11.43	<0.001**
4000	33.04	22.56	10.19	11.67	<0.001**	32.77	22.72	10.58	12.55	<0.001**
6000	27.95	17.76	11.06	7.56	<0.001**	28.13	17.31	11.63	7.65	<0.001**
8000	22.86	12.02	10.96	2.98	<0.001**	22.59	12.61	11.25	4.07	<0.001**

0.05<P<0.10 --+ Suggestive significance; 0.01<P ≤ 0.05 --* moderately significant

P≤0.01 ---** strongly significant

Table 3: Comparison of mean auditory thresholds in right & left ear of subjects residing in Noisy area 2 and residential area:

	Right Ear					Left Ear				
Frequency (Hz)	Noisy Area 2		Residential area		P value	Noisy Area 2		Residential area		P value
	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
250	14.02	4.09	13.27	4.19	0.768	12.14	4.66	13.27	4.19	0.373
500	16.70	3.47	16.06	3.48	0.673	15.27	3.36	16.06	3.48	0.418
1000	19.46	7.43	12.98	4.11	<0.002**	17.95	7.25	12.98	4.11	<0.005**
1500	21.88	12.27	8.37	7.59	<0.001**	21.07	11.35	8.37	7.59	<0.001**
2000	23.75	16.58	5.38	10.19	<0.001**	22.59	16.43	5.38	10.19	<0.001**
3000	27.41	19.14	7.88	11.43	<0.001**	27.23	19.30	7.88	11.43	<0.001**
4000	33.13	22.69	10.58	12.55	<0.001**	32.95	21.95	10.58	12.55	<0.001**
6000	26.79	15.77	11.63	7.65	<0.001**	27.32	15.46	11.63	7.65	<0.001**
8000	21.43	11.47	11.25	4.07	<0.001**	21.89	11.15	11.25	4.07	<0.001**

Table 4: Comparison of mean auditory thresholds in right & left ear of subjects residing in Noisy area 3 and residential area:

Right Ear / Left Ear

Frequency (Hz)	Noisy Area 3		Residential area		P value	Noisy Area 3		Residential area		P value
	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
250	14.35	4.76	13.27	4.19	0.961	12.69	5.02	13.27	4.19	0.657
500	16.57	4.21	16.06	3.48	0.780	16.11	4.31	16.06	3.48	0.962
1000	19.91	8.44	12.98	4.11	<0.002**	19.35	8.58	12.98	4.11	<0.002**
1500	21.85	13.98	8.37	7.59	<0.001**	22.13	13.99	8.37	7.59	<0.001**
2000	24.44	17.50	5.38	10.19	<0.001**	24.63	18.83	5.38	10.19	<0.001**
3000	28.43	19.32	7.88	11.43	<0.001**	29.35	19.81	7.88	11.43	<0.001**
4000	34.35	22.51	10.58	12.55	<0.001**	34.26	22.62	10.58	12.55	<0.001**
6000	28.80	17.80	11.63	7.65	<0.001**	28.61	16.86	11.63	7.65	<0.001**
8000	21.39	10.96	11.25	4.07	<0.001**	21.39	10.25	11.25	4.07	<0.001**

Table 5: Comparison of mean auditory thresholds in right & left ear of subjects residing in Noisy area 4 and residential area:

Right Ear / Left Ear

Frequency (Hz)	Noisy Area 4		Residential area		P value	Noisy Area 3		Residential area		P value
	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
250	15.94	3.93	13.27	4.19	0.265	14.25	4.54	13.27	4.19	0.433
500	18.02	3.71	16.06	3.48	0.109	17.55	3.48	16.06	3.48	0.137
1000	20.57	8.13	12.98	4.11	<0.001**	20.28	7.75	12.98	4.11	<0.001**
1500	21.89	13.24	8.37	7.59	<0.001**	22.36	12.88	8.37	7.59	<0.001**
2000	23.68	17.92	5.38	10.19	<0.001**	23.96	17.63	5.38	10.19	<0.001**
3000	28.30	19.29	7.88	11.43	<0.001**	28.49	20.21	7.88	11.43	<0.001**
4000	33.77	22.59	10.58	12.55	<0.001**	33.96	22.50	10.58	12.55	<0.001**
6000	27.64	16.86	11.63	7.65	<0.001**	27.74	17.11	11.63	7.65	<0.001**
8000	20.28	10.12	11.25	4.07	<0.001**	20.38	10.14	11.25	4.07	<0.001**

Table 6: Comparison of number of subjects having auditory thresholds more than 25 dB in right ear residing in noisy area 1, 2, 3, 4 and residential area:

Frequency	Right Ear									
	Noisy Area1 (n=56)		Noisy Area2 (n=56)		Noisy Area3 (n=54)		Noisy Area 4 (n=53)		Residential Area5 (Control)	
	No	%	No	%	No	%	No	%	No	%
250	-	-	-	-	-	-	-	-	-	-
500	-	-	-	-	1	1.9	-	-	-	-
1000	5	8.9	9	16.1	13	24.1	15	28.3	-	-
1500	26	46.4	26	46.4	28	51.9	27	50.9	2	3.8
2000	33	58.9	33	58.9	28	51.9	32	60.4	5	9.6
3000	33	58.9	33	58.9	33	61.1	32	60.4	5	9.6
4000	33	58.9	33	58.9	33	61.1	32	60.4	5	9.6
6000	33	58.9	32	57.1	33	61.1	32	60.4	5	9.6
8000	25	44.6	30	53.6	18	33.3	13	24.5	-	-

Graph 1: Comparison of number of subjects having auditory thresholds more than 25 dB in right ear residing in noisy area 1, 2, 3, 4 and residential area:

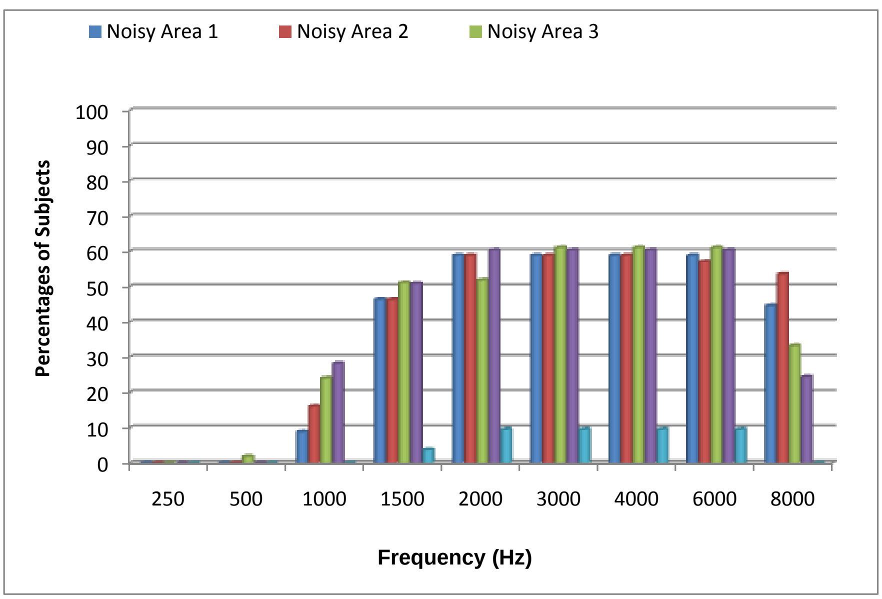

Table 7: **Comparison of number of subjects having auditory thresholds more than 25 dB in left ear residing in noisy area 1, 2, 3, 4 and residential area:**

Frequency	Left Ear									
	Noisy Area1 (n=56)		Noisy Area2 (n=56)		Noisy Area3 (n=54)		Noisy Area 4 (n=53)		Residential Area5 (Control)	
	No	%	No	%	No	%	No	%	No	%
250	-	-	-	-	-	-	-	-	-	-
500	-	-	-	-	-	-	-	-	-	-
1000	2	3.6	2	3.6	13	24.1	8	15.1	-	-
1500	23	41.1	25	44.6	30	55.6	31	58.4	4	7.7
2000	33	58.9	32	57.1	31	57.4	32	60.4	5	9.6
3000	33	58.9	32	57.1	33	61.1	32	60.4	5	9.6
4000	33	58.9	33	58.9	33	61.1	32	60.4	5	9.6
6000	33	58.9	30	53.6	33	61.1	32	60.4	5	9.6
8000	26	46.4	22	39.3	18	33.3	15	28.3	1	1.9

Graph 2: Comparison of number of subjects having auditory thresholds more than 25 dB in left ear residing in noisy area 1, 2, 3, 4 and residential area: