Original Article

Physiology

Effect of Duration of Noise Exposure on Auditory Impairment in the Population of Bangalore City.

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ABSTRACT

Background and Objectives: Noise pollution in an urban city like Bangalore is a serious problem and is steadily increasing over the years. The relationship between duration of noise exposure and hearing loss in normal subjects residing in an urban city like Bangalore is yet to be investigated. The aim of this study was to determine the relationship between duration of noise exposure and degree of auditory impairment in a cross-sectional population of Bangalore city.

Methods: 219 normal subjects residing in noisy roads in four geographical areas belonged to the research group were subjected to a pure tone audiometric assessment. The resulting data was statistically analyzed with SPSS software.

Results: The auditory threshold (degree of hearing impairment) was very high in subjects which exposed to noise for more than 15 years than the subjects who were exposed to noise below 15 years at the frequencies 1000, 1500, 2000, 3000, 4000, 6000 and 8000 Hz in both ears.

Conclusion: The duration of exposure to noise had a direct effect on degree of hearing impairment in subjects of noisy areas. Subjects residing in noisy areas have an increased risk of noise induced hearing loss.

Key Words: Noise, audiometry, hearing loss

KEY MESSAGE

- The noise above the maximum limited level is extremely harmful to normal ability of the persons to hear and the duration of noise exposure is directly proportional to hearing impairment.

INTRODUCTION

Technology development in commerce, communication and education has enhanced the urban growth both in developed and developing countries [1]. There have been many references on the effect of exposure of noise on hearing impairment and because of that there have been hearing impairment in many people of Bangalore city which needs to be investigated. The sources of community of noise include traffic, railway, aircraft and construction. The traffic includes large trucks, motorcycles, constant traffic etc. An individual's noise exposure is a measure of the noise experienced by the individual over a period of time. A noise level is a measure of noise at a given instant in time. The noise levels rarely persist consistently over a long period of time and the community noise varies continuously with time with respect to the contributing sound sources of the community noise environment. It is primarily the product of many distant noise sources, which constitute a relatively stable background noise exposure, with individual contributors unidentifiable [2].The evidence of noise induced hearing loss is strong and comes from historical, observational and animal studies. The cause and effect relationship between noise exposure and hearing loss has been appreciated for many years. "Boilermaker's deafness" was a term coined in the 1700's and 1800's to a high frequency hearing loss seen in laborers who could be diagnosed with tuning fork [3]. 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 [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 an auditory acuity in a cross-sectional population in different areas of Bangalore city.

MATERIALS AND METHODS

The study was conducted on a sample of 271 normal subjects after informed, written and verbal consent in Bangalore between April to September 2006. Our research comprised 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 included 56, 56, 54 and 53 subjects respectively. The selection of subjects was based on the fact that they were staying in different

noisy areas (exposed to traffic noise for 8 hours/day or more for a duration of 15 years or more). This group included street-vendors, shopkeepers along with the roadside, traffic policemen, drivers and conductors of BMTC ("Bangalore Metropolitan Transport Corporation"). The selection of subjects was based on inclusion-exclusion criteria. Inclusion criteria included age group between 20 to 50 yrs and subjects who were staying in selected noisy areas for at least fifteen years while the patients suffering from hypertension, diabetes or patients using ototoxic drugs since the previous 3 months or having a history of ear surgeries or recent ear, nose, throat infections were excluded. Prior approval from Institutional ethics committee was taken for the said research.

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

RESULTS

In the present study, there were two groups of subjects, one group consisting of 219 normal subjects residing in noisy roads in four geographical areas (West, North, South, East).

[Tables/Fig 1,2,3,4] show the results of the subjects working in noisy areas. It was prepared and rearranged as per requirement of the parameters discussed. It is important to first appreciate that the noise levels in the 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 subjects belonging to noisy area 1, 2, 3, 4 have been selected and matched with respect to age to remove the effect of presbycusis [9]. It is of the prime importance to appreciate that the 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 the present study only those subjects were selected who were staying in the respective area for a minimum of 10 years and exposed to noise for a period of minimum 8 hrs/day. The noise induced hearing loss begins with selective loss of hearing at around 4000 Hz, with thresholds better at both higher and lower frequencies which can be interpreted while comparing the auditory mean threshold of [Table/Fig-1] to [Table/Fig-4] at various 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 [9]. [Table/Fig-5] compares the auditory thresholds of right and left ear in noisy areas 1,2,3 and 4.

Frequency (Hz)	Side	Duration of exposure in years in Area 1				P value
		<15 years		>15 years		
		Mean	SE	Mean	SE	
250	Right	14.84	0.94	12.40	0.96	0.078
	Left	12.42	0.83	10.60	0.83	0.132
500	Right	15.97	0.78	16.00	0.76	0.977
	Left	15.00	0.66	15.20	0.61	0.822
1000	Right	17.10	1.08	22.40	1.05	0.001
	Left	16.61	0.88	20.60	1.01	0.004
1500	Right	17.26	1.90	27.40	1.76	<0.001**
	Left	17.74	1.70	26.80	2.02	<0.001**
2000	Right	17.74	2.83	32.00	2.80	<0.001**
	Left	17.42	2.86	32.20	2.81	<0.001**
3000	Right	19.35	3.38	36.00	3.27	<0.001**
	Left	19.35	3.49	37.60	3.38	<0.001**
4000	Right	24.84	3.89	43.20	3.93	<0.001**
	Left	24.19	3.93	43.40	3.86	<0.001**
6000	Right	20.16	2.51	37.60	3.48	<0.001**
	Left	20.16	2.49	38.00	3.24	<0.001**
8000	Right	17.58	1.76	29.40	2.28	<0.001**
	Left	16.94	1.91	29.60	2.29	<0.001**

[Table/Fig-1]: Comparison between auditory mean thresholds of subjects exposed to noise more or less than 15 years in noisy area 1
*0.05<P<0.10 - + Suggestive significance; 0.01<P ≤ 0.05 - * Moderately significant; P≤0.01 - ** Strongly significant*

Frequency (Hz)	Side	Duration of exposure in years in Area 2				P value
		<15 years		>15 years		
		Mean	SE	Mean	SE	
250	Right	14.29	0.76	13.75	0.80	0.629
	Left	12.68	0.87	11.61	0.89	0.394
500	Right	16.07	0.60	17.32	0.70	0.181
	Left	14.82	0.65	15.71	0.61	0.325
1000	Right	15.36	1.23	23.57	1.12	<0.001**
	Left	14.11	1.29	21.79	1.04	<0.001**
1500	Right	14.82	2.19	28.93	1.57	<0.001**
	Left	14.64	1.85	27.50	1.70	<0.001**
2000	Right	14.64	3.02	32.86	2.17	<0.001**
	Left	14.11	2.72	31.07	2.63	<0.001**
3000	Right	17.68	3.27	37.14	2.99	<0.001**
	Left	17.32	3.32	37.14	2.97	<0.001**
4000	Right	21.96	4.00	44.29	3.50	<0.001**
	Left	22.14	3.82	43.75	3.44	<0.001**
6000	Right	18.57	2.50	35.00	2.61	<0.001**
	Left	19.46	2.47	35.18	2.59	<0.001**
8000	Right	15.54	1.71	27.32	2.02	<0.001**
	Left	15.89	1.57	27.89	1.98	<0.001**

[Table/Fig-2]: Comparison between auditory mean thresholds of subjects exposed to noise more or less than 15 years in noisy area 2
00.05<P<0.10 --+ Suggestive significance; 0.01<P ≤ 0.05 -- Moderately significant; P≤0.01 ---** Strongly significant*

Frequency (Hz)	Side	Duration of exposure in years in Area 3				P value
		<15 years		>15 years		
		Mean	SE	Mean	SE	
250	Right	13.75	0.84	15.23	1.01	0.267
	Left	11.41	0.88	14.55	0.98	0.022
500	Right	15.47	0.72	18.18	0.84	0.019
	Left	14.69	0.71	18.18	0.84	0.003
1000	Right	16.09	1.42	25.45	1.18	<0.001**
	Left	15.47	1.32	25.00	1.47	<0.001**
1500	Right	15.31	2.41	31.36	1.65	<0.001**
	Left	15.31	2.28	32.05	1.85	<0.001**
2000	Right	16.56	3.00	35.91	2.29	<0.001**
	Left	15.94	3.29	37.27	2.15	<0.001**
3000	Right	19.69	3.28	41.14	2.59	<0.001**
	Left	20.63	3.43	42.05	2.62	<0.001**
4000	Right	24.22	3.87	49.09	2.92	<0.001**
	Left	23.59	3.84	49.77	2.78	<0.001**
6000	Right	20.78	2.82	40.45	2.89	<0.001**
	Left	20.78	2.54	40.00	2.89	<0.001**
8000	Right	16.09	1.61	29.09	1.85	<0.001**
	Left	16.09	1.42	29.09	1.73	<0.001**

[Table/Fig-3]: Comparison between auditory mean thresholds of subjects exposed to noise more or less than 15 years in noisy area 3
0.05<P<0.10 --+ Suggestive significance; 0.01<P ≤ 0.05 -- Moderately significant; P≤0.01 ---** Strongly significant*

Frequency (Hz)	Side	Duration of exposure in years in Area 4				P value
		<15 years		>15 years		
		Mean	SE	Mean	SE	
250	Right	15.23	0.22	15.00	0.96	0.099
	Left	14.55	0.21	16.79	0.53	0.011
500	Right	18.18	0.18	16.40	0.68	0.002
	Left	18.18	0.18	19.46	0.65	0.070
1000	Right	25.45	0.25	16.20	1.30	<0.001**
	Left	25.00	0.31	24.46	1.42	<0.001**
1500	Right	31.36	0.35	15.00	2.47	<0.001**
	Left	32.05	0.39	28.04	2.06	<0.001**
2000	Right	35.91	0.49	15.40	3.32	<0.001**
	Left	37.27	0.46	31.07	3.01	<0.001**
3000	Right	41.14	0.55	19.60	3.68	<0.001**
	Left	42.05	0.56	36.07	3.17	<0.001**
4000	Right	49.09	0.62	23.20	4.25	<0.001**
	Left	49.77	0.59	43.21	3.71	<0.001**
6000	Right	40.45	0.62	18.60	2.35	<0.001**
	Left	40.00	0.62	35.71	3.17	<0.001**
8000	Right	29.09	0.39	14.60	1.19	<0.001**
	Left	29.09	0.37	25.36	1.97	<0.001**

[Table/Fig-4]: Comparison between auditory mean thresholds of subjects exposed to noise more or less than 15 years in noisy area 4
0.05<P<0.10 --+ Suggestive significance; 0.01<P ≤ 0.05 -- Moderately significant; P≤0.01 ---** Strongly significant*

Frequency (Hz)	Area1		Area 2		Area 3		Area 4	
	Left	Right	Left	Right	Left	Right	Left	Right
250	13.75 ± 5.16	11.61 ± 4.48	14.02 ± 4.09	12.14 ± 4.66	14.35 ± 4.76	12.69 ± 5.02	15.94 ± 3.93	14.25 ± 4.54
500	15.98 ± 4.09	15.09 ± 3.37	16.70 ± 3.47	15.27 ± 3.36	16.57 ± 4.21	16.11 ± 4.31	18.02 ± 3.71	17.55 ± 3.48
1000	19.46 ± 6.23	18.39 ± 5.32	19.46 ± 7.43	17.95 ± 7.25	19.91 ± 8.44	19.35 ± 8.58	20.57 ± 8.13	20.28 ± 7.75
1500	21.79 ± 10.97	21.79 ± 10.68	21.88 ± 12.27	21.07 ± 11.35	21.85 ± 13.98	22.13 ± 13.99	21.89 ± 13.24	22.36 ± 12.88
2000	24.11 ± 16.49	24.02 ± 16.72	23.75 ± 16.58	22.59 ± 16.43	24.44 ± 17.50	24.63 ± 18.83	23.68 ± 17.92	23.96 ± 17.63
3000	26.79 ± 19.48	27.50 ± 20.36	27.41 ± 19.14	27.23 ± 19.30	28.43 ± 19.32	29.35 ± 19.81	28.30 ± 19.29	28.49 ± 20.21
4000	33.04 ± 22.56	32.77 ± 22.72	33.13 ± 22.69	32.95 ± 21.95	34.35 ± 22.51	34.26 ± 22.62	33.77 ± 22.59	33.96 ± 22.50
6000	27.95 ± 17.76	28.13 ± 17.31	26.79 ± 15.77	27.32 ± 15.46	28.80 ± 17.80	28.61 ± 16.86	27.64 ± 16.86	27.74 ± 17.11
8000	22.86 ± 12.02	22.59 ± 12.61	21.43 ± 11.47	21.89 ± 11.15	21.39 ± 10.96	21.39 ± 10.25	20.28 ± 10.12	20.38 ± 10.14

[Table/Fig-5]: Comparison of auditory thresholds (dB) between right and left ears in noisy areas 1, 2, 3, and 4:

DISCUSSION

In this study, the auditory acuity of normal subjects residing in noisy areas 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. Overall, the mean auditory thresholds of subjects exposed to noise more than15 years were higher as compared with subjects exposed to noise less than 15 years. Our findings are very well in correlation with the research on 'Effect of traffic noise on hearing loss of people', which shows a strong direct association between noise induced hearing loss and the duration of exposure time [10].

REFERENCE

[1] Joshi SK, Devkota S, Chamling S, Shrestha S. Environmental noise induced hearing loss in Nepal. Kathmandu University Medical Journal (2003) Vol. 1, No. 3, 177-83.
[2] Environmental, setting impacts, and mitigation measures [access date 2004 October 7]. Available from: URL: http://WWW.semprafiber-fig.net/deir/4_5_noise.pdf.
[3] Rosen EJ. Noise induced hearing loss. Grand Rounds Presentation, UTMB, Dept. of Otolaryngology. 2001 January 10. [access date 2006 March 16]. Available from: URL: http://www.utmb.edu/otoref/Grnds/Hear-Loss-Noise-000110/Hear-Loss-Noise.pdf
[4] Rabinowitz PM. Noise induced hearing loss. American Academy of Family Physicians. 2000 May 1; 61:2749-56, 2759-60.
[5] Noise City. Noise pollution can lead to several health risks. Deccan Herald. 2006 June 16. [access date 2006 August 20]. Available from: URL: http://www.deccanherald.com/deccanherald/jun162006/editpage.asp

[6] Kerr AG, Stephans D. Scott-Brown's Otolaryngology: Adult Audiology; volume 2; 6th edition, pp 2/1/6-9, Butterworth Heinemann, 1997.
[7] Sanders JW, Katz J. Silverman's text book of audiometry. pp 10-65, Williams and Wilkins 1982.
[8] Sandra Gordon-Salant. Determining Threshold Level for Speech, American speech and hearing Association, committee on audiometric evaluation (1978a). Guidelines for manual pure tone threshold audiometry. Asha, 20: 297-301.
[9] Jorgensen MB. Histological studies on changes of aging in the inner ear. Arch Otolaryngol 1961; 74: 56-62.
[10] Itrat Jawed. The effect of traffic noise on the hearing level of people on Karachi streets, Journal of Pakistan Medical Association, October 2010; 60-10, 813-6.

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