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A COMPARATIVE STUDY OF AUDIOMETRY IN URBAN BANGALOREAN SENIOR CITIZENS AND RURAL BANGALOREAN SENIOR CITIZENS

Dr. Shruthi. K[1], Dr. Ramya. R[2], Dr. Siva Kumar V[3], Dr B Jaya[4*], Dr. Ipsita Debata[5], Dr. Tejas. J[6], Dr. Venkatesh. S[7]

[1]Associate Professor, Department of Physiology, Prathima Institute of Medical Sciences, Nagunur, Karimnagar – 505417, Telangana, India.
[2]Associate Professor, Department of Physiology, Apollo Institute of Medical Sciences and Research, Chittoor - 517127, Andhra Pradesh, India.
[3]Associate Professor, Department of Forensic Medicine and Toxicology, Apollo Institute of Medical Sciences and Research, Chittoor - 517127, Andhra Pradesh, India.
[4]Associate professor, Department of Physiology, Karpaga Vinayaga Institute of Medical sciences and Research centre, GST road, Chinna Kolambakkam, Palayanoor (po), Madhuranthagam(Tk), Chengalpattu (dt) 603 308
[5]Associate Professor, Department of Community Medicine, Kalinga Institute of Medical Sciences, Kushabhadra Campus, 5, KIIT Rd, Bhubaneswar, Odisha 751024.
[6]Professor, Department of Forensic Medicine and Toxicology, Karpaga Vinayaga Institute of Medical sciences and Research centre, GST road, Chinna Kolambakkam, Palayanoor (po), Madhuranthagam (Tk), Chengalpattu (dt) 603308.
[7]Professor, Department of Physiology, Bangalore Medical College and Research Institute, Bengaluru - 560002, Karnataka, India.

***Corresponding author:** Dr. B. Jaya, Associate Professor, Department of Physiology, Karpaga Vinayaga Institute of Medical Sciences and Research Centre, GST Road, Chinna Kolambakkam, Palayanoor (po), Madhuranthagam(Tk), Chengalpattu (dt) 603 308.

ABSTRACT

Introduction: Globally, 430 million people require rehabilitation to address their disabling hearing loss. Prevalence of hearing loss increases with age, among those older than 60 years. The present study aimed to assess the auditory acuity in senior citizens residing in Bangalore urban areas and to compare them with the auditory acuity of senior citizens who are residing in Bangalore rural (less noise polluted) areas.

Objectives: (a) to record Pure Tone Audiometry (PTA) in urban and rural Bangalore senior citizens. (b) To compare and analyse the effects of noise on hearing.

Materials and methods: This prospective, comparative study was conducted in Department of Physiology, Bangalore Medical College and Research Institute, Bengaluru, Karnataka, India. In the present study, 60 senior citizens residing in noise polluted four geographical areas of Bangalore were included as cases and 60 senior citizens who are non-residents of urban Bangalore were included as controls. The study subjects were included after approval from the institutional ethics committee and informed consent was obtained from all the study participants. In this study, Arphi 500 MK 1 Audiometer was used to record the pure tone audiometric thresholds manually. The pure tone audiometer is made of Oscillator, pulse

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former, Attenuator, Amplifier, the second channel constituting- Random noise generator, Band-pass filter, Attenuator and Amplifier.
Results: In the present study, 120 subjects were included, among them 60 were cases and 60 were controls. In this study, the mean age of the cases was 64.9±3.31 years, controls 64.78±4.24 years, there was no significant difference in age. The threshold of air conduction in right and left ear is increased significantly in cases than controls at all frequencies i.e., 0.25, 0.5, 1, 2, 4, 6 and 8 kHz. In the current study, the threshold of bone conduction in right and left ear is increased significantly in cases than controls at all frequencies i.e., 0.25, 0.5, 1, 2 and 4 kHz. In the urban Bangalorean senior citizens group, 68.33% have normal hearing, 30% have mild hearing loss, and 1.6% have moderate hearing loss as compared to rural Bangalorean senior citizens group. Among cases 31.6% had some degree of hearing loss, compared to only 11.6% among controls.
Conclusion: The present study results conclude that senior citizens from more noise polluted areas had raised air conduction thresholds at all frequencies i.e., 0.25, 0.5, 1, 2, 4, 6 and 8 kHz, also raised bone conduction thresholds at all frequencies i.e., 0.25, 0.5, 1, 2 and 4 kHz. Prevalence of hearing impairment is more in urban Bangalore senior citizens compared to rural Bangalore senior citizens. Chronic exposure to noise compounds the hearing loss that is produced by ageing process alone.
Keywords: Air conduction, bone conduction, Noise – Induced Hearing loss

INTRODUCTION

Globally as well as in India elderly population is rapidly increasing over the years. The proportion of world's elderly population will double from 11% to 22%, between 2000 and 2050. In 2000, the number of people aged ≥ 60 years is 605 million and is expected to increase 2 billion in 2050. In India, the proportion of elderly was 8% in 2012 and is expected to increase to 19% in 2050 [1].

Globally, 430 million people require rehabilitation to address their disabling hearing loss. It is estimated that by the year 2050, one in ten people will have disabling hearing loss. It has been reported that in low- and middle- income countries, nearly 80% of people are with disabling hearing loss and the prevalence increases with age, among those ≥ 60 years, over 25% are affected by disabling hearing loss [2]. In 2018, WHO reported that the prevalence of hearing impairment (HI) in India is around 6.3%, adult-onset deafness is 7.6% and childhood-onset deafness is 2% [3]. The prevalence of disabling hearing loss among children as well as elderly is highest in Asia Pacific and Sub- Saharan Africa [4].

Hearing losses that commonly occur due to chronic exposure to high-level sound [Noise-induced hearing loss (NIHL)] and those we attribute to age [age-related hearing loss (AHL) or Presbycusis] are major health issues and their consequences are permanent [5].

Globally, concerns towards noise pollution have been increased, especially in urban centres. The noise problem of the modern industrial societies seems incomparable to the past given the larger sources of noise now present outdoors and indoors. According to WHO, traffic noise is one of the sources of environmental noise exposure [6].

NIHL is a bilaterally symmetrical, irreversible sensori-neural hearing loss associated with excessive noise exposure. Increasing age is associated with increasing disability and functional impairment, one such is the hearing impairment in the elderly [7]. Rapid urbanization and industrialization in the last few decades have increased the level of noise

due to automobiles and industrial machineries which further aggravates the hearing impairment in the elderly. A lifetime regular exposure to noise is likely to have negative effects on hearing [8]. The present study aimed to assess the auditory acuity in senior citizens residing in Bangalore urban areas and to compare it with the auditory acuity of senior citizens who are residing in Bangalore rural (less noise polluted) areas.

Objectives: (a) to record Pure Tone Audiometry (PTA) in urban Bangalore senior citizens and rural Bangalore senior citizens. (b) To compare and analyse the effects of noise on hearing.

MATERIALS AND METHODS

This prospective, comparative study was conducted in Department of Physiology, Bangalore Medical College and Research Institute, Bengaluru, Karnataka, India. In this study, 60 senior citizens residing in noise polluted four geographical areas of Bangalore (East, West, North, South) were considered as cases and 60 senior citizens who are non-residents of urban Bangalore (quieter - less noise polluted areas) were considered as controls. The study has been approved by the institutional ethics committee and informed consent was obtained from all the study participants.

Method of collection of data (including sampling procedure)

Sixty senior citizens residing in noise polluted four geographical areas of urban Bangalore (East, West, North and South). Fifteen each from the following areas: Indiranagar, Rajajinagar, Hebbal and Kalasipalya) and 60 senior citizens who are residents of rural (quieter) areas of Bangalore (Hoskote) were taken as controls. Both male and females were included in the study.

Inclusion Criteria

Senior citizens of age group 60 years and above, residing in urban or rural Bangalore for a minimum period of 10 years, should possess verbal communication skills necessary to understand and respond to questions were included in the study.

Exclusion Criteria

Age group below 60 years, BMI $\geq$ 25 kg/m^2, history of acute or chronic otorhinological disorders, subjects using hearing aids, subjects on ototoxic drugs or sedatives, past history of tuberculosis and any neurological disorders, history of metabolic disorders like Diabetes mellitus and Hypertension, history of smoking and alcohol intake were excluded from the study.

Equipment

Arphi 500 MK 1 Audiometer was used to record the pure tone audiometric thresholds manually. The pure tone audiometer is made of Oscillator, pulse former, Attenuator, Amplifier, the second channel constituting- Random noise generator, Band-pass filter, Attenuator and Amplifier.

Statistical analysis

Results were presented as Mean ± SD and categorical variables were expressed as percentages. Chi-square/Fisher Exact test was used. P value <0.05 considered as statistically significant. Statistical analysis was done by using licensed version of SPSS 18.0.

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RESULTS

120 subjects were included, among them 60 were cases & 60 were controls. In this study, the mean age of the cases was 64.9±3.31 years whereas in controls 64.78±4.24 years, which was statistically insignificant (p=0.857). In this study, among cases, 24 were females and 36 were males whereas in controls, 22 were females and 38 were males.

In this study, the threshold of air conduction in right ear significantly increased in urban senior citizens group (cases) than rural senior citizens group (controls) as shown in table/fig-1.

Table/fig - 1: Hearing threshold (auditory assessment) in decibels in cases and controls in Right ear- Air conduction (AC)

Sound Frequency (Hertz): AC	Cases Mean±SD (n=60)	Controls Mean±SD (n=60)	P Value
AC 250	23.17±5.60	12.5±7.33	< 0.001*
AC 500	23.92±5.90	11.66±8.16	< 0.001*
AC 1000	23.83±7.33	10±8.82	< 0.001*
AC 2000	24.58±7.99	10.16±8.87	< 0.001*
AC 4000	26.58±9.18	7.50±4.17	< 0.001*
AC 6000	24.08±6.67	10.5±9.37	< 0.001*
AC 8000	23.58±7.19	13.08±10.08	< 0.001*

* Significant (p<0.05)

In this study, the threshold of air conduction in left ear significantly increased in urban senior citizens group (cases) than rural senior citizens group (controls) as shown in table/fig-2.

Table/fig-2: Hearing threshold (auditory assessment) in decibels in the cases and controls in Left ear- Air conduction (AC)

Sound Frequency (Hertz): AC	Cases Mean±SD (n=60)	Controls Mean±SD (n=60)	P Value
AC 250	23.00±5.68	12.58±7.99	< 0.001*
AC 500	23.17±6.10	11.08±8.68	< 0.001*
AC 1000	23.58±7.14	10.25±9.13	< 0.001*
AC 2000	24.91±8.25	10.25±9.27	< 0.001*
AC 4000	26.5±9.1	10.833±10.46	< 0.001*
AC 6000	23.91±6.95	11.66±10.48	< 0.001*
AC 8000	23.5±6.89	12.58±10.31	< 0.001*

* Significant (p<0.05)

In the current study, the threshold of bone conduction in right ear significantly increased in urban senior citizens group (cases) than the rural senior citizens group (controls) as shown in table/fig-3.

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Table/fig-3: Hearing threshold (auditory assessment) in decibels in the cases and controls in Right ear- Bone conduction (BC)

Sound Frequency (Hertz): BC	Cases Mean±SD (n=60)	Controls Mean±SD (n=60)	P Value
BC 250	26.58±4.65	17.08±6.5	< 0.001*
BC 500	26.42±5.53	16.5±7.1	< 0.001*
BC 1000	26.83±6.51	14.91±7.72	< 0.001*
BC 2000	27.58±6.34	14.4±7.76	< 0.001*
BC 4000	29.17±7.26	14.83±8.02	< 0.001*

* Significant (p<0.05)

In this study, the threshold of bone conduction in left ear significantly increased in urban senior citizens group (cases) than the rural senior citizens group (controls) as shown in the table/fig-4.

Table/fig-4: Hearing threshold (auditory assessment) in decibels in the cases and controls in Left ear- Bone conduction (BC)

Sound Frequency (Hertz): BC	Cases Mean±SD (n=60)	Controls Mean±SD (n=60)	P Value
BC 250	26.75±5.43	17.33±7.33	< 0.001*
BC 500	26.41±4.88	15.66±7.89	< 0.001*
BC 1000	26.83±6.37	14.83±8.33	< 0.001*
BC 2000	27.58±6.40	14.58±8.09	< 0.001*
BC 4000	29.08±7.39	14.91±9.08	< 0.001*

* Significant (p<0.05)

In the study, the urban Bangalorean senior citizens group, 68.3% have normal hearing, 30% have mild hearing loss, 1.6% have moderate hearing loss as compared to rural Bangalorean senior citizens group among whom 88.3% have normal hearing, and only 11.6% have mild hearing loss. Among cases 31.6% had some degree of hearing loss, compared to only 11.6% among controls as shown in table/fig-5.

Table/Fig-5: Hearing loss between the cases and controls

Hearing Loss	Cases (n=60)		Controls (n=60)	
	No.	%	No.	%
Normal	41	68.3	53	88.3
Mild	18	30	7	11.6
Moderate	1	1.6	0	0.0
Moderately severe	0	0.0	0	0.0
Severe	0	0.0	0	0.0
Total number of individuals with hearing loss	19	31.6	7	11.6

DISCUSSION

Hearing loss is one of the most common sensory impairments. Globally, the fourth leading source of disability among all age groups. Hearing loss has a profound impact on the

individuals and it leads to decrease in quality of life [9]. The industrial and technological revolution has made the world a noisier place to live. Therefore, noise pollution is considered as a health hazard. Acoustic trauma to the ear occurs due to continued or repeated exposures to high intensity sound and this trauma leads to hearing loss, ringing in the ears (tinnitus) and occasional dizziness (vertigo), and also increases in heart rate and blood pressure (non-auditory effects) [10].

Sensorineural hearing loss associated with aging process in the ear is called Presbycusis and affecting a third of people aged between 65 and 75 years and up to half of people ≥75. It manifests early if there is hereditary predisposition, chronic noise exposure or a generalized vascular disease [11].

Exposure to excessive sound dulls hearing and may damage the ear. If moderate it produces a temporary threshold shift (TTS), which if the ear is allowed to rest, recovers after a short time. The mechanism is metabolic exhaustion and recovery. If the sound is sufficiently intense or after repeated exposures, recovery is often incomplete and it produces a much more severe TTS, which may go on to become a permanent threshold shift (PTS) and a residual hearing impairment remains [12].
NIHL is a result of chronic exposure to less intense sounds. The audiogram in NIHL shows a typical notch at 4 kHz, both for air conduction and bone conduction, it is usually symmetrical on both sides. As the duration of noise exposure increases, the notch deepens and widens to involve lower and higher frequencies. Hearing impairment becomes clinically apparent to the patient when the frequencies of 500, 1000 and 2000 Hz (speech frequencies) are also affected [11].

Age related decrement in auditory acuity is a natural phenomenon [12]. In the elderly, both cases and the control group were age matched, therefore Presbycusis can be presumed to be a common factor for both the groups. In our study, it was observed that urban senior citizen had greater decrease in auditory acuity than that can be attributed to ageing process alone, as was demonstrated by comparing with age matched controls. The decrement in auditory acuity in cases was seen in all frequencies reaching greatest extent around 4000Hz, which is a typical finding in Noise induced hearing loss. The proportion of individuals with mild to moderate hearing loss is significantly higher among urban senior citizen than in rural senior citizen. These observations support the hypothesis that chronic exposure to noise will lead to greater hearing damage in the elderly than the effect of ageing alone.

In support of the present study, a study conducted by Joshi SK et al., on environmental noise induced hearing loss reported that, among the controls (not exposed to noise) 13.5% of the total sample surveyed had the noise induced hearing loss. Among the cases (exposed to noise), the number of Noise induced hearing loss was about three times higher than that of non-exposed group. Among the cases, 39.34 % were found to have Noise induced hearing loss [13]. In a study conducted by Eileen Daniel D Ed, reported that NIHL is a major cause of deafness and though treatment options were limited for most people with noise-related hearing loss, several modifiable health behaviours if done at an earlier age might prevent or delay the onset of hearing impairment [14]. Another study by Antonio Sergio Melo Barbosa et al., reported that the prevalence of noise induced hearing loss was more in the people working in the noisier areas than those working in lower noise levels, suggested that occupational exposure to urban noise plays an important role [15].

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In the study of noise-induced hearing impairment among Nigerian traders done by ADA Ighoroje et al., they determined the ambient noise levels in their workplaces to be over 90dB. Study reported that by 4-8 years of exposure, 100% of the Sawmill workers had developed determinable impairment. By the same period, over 84% of the marketers of recorded music had developed air conduction impairment in the right ear, while about 94% of food processors had the impairment. They also reported that NIHL occurred predominantly in higher frequencies, 300 - 600 Hz, with largest effect observed at 4000Hz. They observed that with increasing exposure, NIHL was also detected at lower frequencies, more at 2000 Hz and air conduction impairment was more frequent compared to bone conduction impairment [16].

Yet another study by Roberto Albera et al., on evolution of NIHL, influence of age and exposure to noise it was seen that, hearing loss was found to be more related to age than to noise exposure. The authors concluded that once NIHL has manifested, it tends to worsen slightly with continued noise exposure and that progressive hearing loss is chiefly due to aging [17]. In a recent study by Luigi De Maria et al., also reported that a significantly higher prevalence of age-related hearing loss (ARHL) among workers exposed to noise [18].

Anna Rita Fetoni et al., conducted an animal model [animal model of ARHL (C57BL/6 mice)] study to evaluate if NIHL could affect the onset or progression of age-related cochlear dysfunction, reported that hearing loss can exacerbate ARHL, damaging sensorineural Cochlear epithelium and causing synaptopathy [19]. Zhuang Jiang et al., reported that hearing loss was very rapid at 12 kHz than the other frequencies, among the workers of shipyard. Workers with clinically normal hearing but high cumulative noise exposure are likely to exhibit deficits in speech and temporal processing [20]. Gopinath B et al., also reported that workplace noise exposure increased the risk of incident hearing loss in older adults [21].

Limitation(s)
This study was limited by a relatively small sample size. Further, studies with large sample size are recommended.

CONCLUSION (S)

The present study results may conclude that senior citizens from more noise polluted areas showed significantly increased air conduction thresholds at all frequencies i.e., 0.25, 0.5, 1, 2, 4, 6 and 8 kHz, as well as raised bone conduction thresholds at all frequencies i.e., 0.25, 0.5, 1, 2 and 4 kHz. Prevalence of hearing impairment is more in urban Bangalore senior citizens compared to rural Bangalore senior citizens. Chronic exposure to noise compounds the hearing loss that is produced by ageing process alone. Thus, it is crucial that loud noise exposure has to be minimized. Reducing the amount of time exposed to loud noise, protecting ears with ear plugs or ear muffs can also come a long way in protecting hearing and limiting the amount of hearing loss. However, further studies with large sample size are needed to support these findings.

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