Audiological Characteristics in the Elderly Population: Indian Context

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This Dissertation is submitted as part fulfillment

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DEDICATED TO

DR. DEVI PRASAD SIR,

DR. SUJEET SIR

& MY FAMILY

CERTIFICATE

This is to certify that this dissertation entitled **"Audiological Characteristics in the Elderly Population: Indian Context"** is a bonafide work submitted in part fulfillment for the Degree of Master of Science (Audiology) of the student (Registration No: 13AUD014). This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any of the University for the award of any other Diploma or Degree.

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This is to certify that this dissertation entitled **"Audiological Characteristics in the Elderly Population: Indian Context"** has been prepared under my supervision and guidance. It is also certified that this has not been submitted earlier in other University for the award of any Diploma or Degree.

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DECLARATION

This is to certify that this dissertation entitled **"Audiological Characteristics in the Elderly Population: Indian Context"** is the result of my own study under the guidance of Dr. Sujeet Kumar Sinha, Lecturer in Audiology, Department of Audiology, All India Institute of Speech and Hearing, Mysuru, and has not been submitted earlier in other University for the award of any Diploma or Degree.

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Abstract

Presbycusis is a condition which is characterized by reduced hearing sensitivity, affected speech understanding ability in noisy environments, slowed central processing of the acoustic information along with impaired localization of the sound sources. Ageing shows it's affect in any part of the ear starting from the outer ear to the inner ear and also any stage of sound stimulus to its perception. So it is necessary to understand it's prevalence and audiological characteristics in Indian population, where there is a dearth of studies reporting the same. Thus this study was taken up with an objective to report the different audiological characteristics in the elderly individuals (aged above 60 years) who reported with the ear or hearing related complaints to Department of Audiology, All India Institute of Speech and Hearing, Mysore between July 2013 and April 2014. A register-based study was employed, where the case files of 1053 individuals in the age group of 60 to 98 years were reviewed. The various audiological test results which were documented for these clients are Pure-tone Audiometry results, Immittance Test results, Oto-Acoustic Emissions, Auditory Brainstem Responses and Hearing Aid fitment. The results show that, all the above tests results are affected or show deviation from the normal range in a majority of the individuals more than 60 years with a dominance of affected male subjects. Most of the tests have shown a larger age and gender effects on them, compared to the normal range except, for the Tympanometry which didn't account much change as people age. Thus this study gives a good insight into the various audiological findings obtained in the older Indians.

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Chapter 1

INTRODUCTION

Presbycusis is a condition associated with symmetrical hearing deficit which occurs after attaining the age of 65 years and with no underlying cause (Irwin, 1987). It refers to loss of hearing in the older people and it accounts for the result of a lifetime insults occurring to the auditory system (Gates and Mills, 2005). It is a condition characterized by decrement in hearing, affected speech comprehension ability in noisy environments, reduced central processing of the acoustic information along with impaired localization of the sound sources (Gates and Mills, 2005). This results in a considerable social, communication and emotional malfunction in the older people (Weinstein & Ventry, 1982; Bess et al., 1989; Herbst et al., 1990; Mulrow et al., 1990; Bazargan et al., 2001).

Ageing can show it's affect in any part of the ear starting from outer ear to the inner ear and also any stage of sound stimulus to its perception. Ageing also results in the collapsing of cartilaginous external auditory meatus, tympanic membrane and the ossicular chain stiffening (Howarth et al., 2006). The sensory, neural, vascular, synaptic, supporting, and the mechanical structures in the peripheral and central auditory structures are also affected by the process of ageing. The sensory cells (the outer and inner hair cells), supporting cells, tectorial membrane, reissner's membrane, and stria vascularis also get affected due to process of ageing. Ageing also affects the central auditory structures resulting in a decrease in the number of neurons to the cochlear nucleus and the auditory centres of the brain (Howarth et al., 2006).

Quite a few investigations tried to explore the possible changes to the middle ear functioning in older adults. Though there is no clear evidence on changes in resonance frequency (Holte, 1996; Wiley et al, 1999; Uchida et al, 2000) and the functioning of eustachian tube (Chermak and Moore, 1981), variable results exist in regards to the changes in Tympanometric measures in older adults. Many studies have reported no significant differences in the middle ear static compliance with ageing (Nerbonne et al., 1978; Osterhammel and Osterhammel, 1979; Thompson et al., 1979; Wilson, 1981; Holte, 1996; Uchida et al., 2000; Stenklev et al., 2004). However, there is also evidence that the static compliance values are relatively lower in older adults (Jerger et al, 1972; Blood and Greenberg, 1977; Hall, 1979; Gates et al, 1990; Wiley et al, 1996), which indicating hardening of middle ear structures as ageing advances. (Jerger et al., 1972; Blood and Greenberg, 1977; Hall, 1979; Feeney and Sanford, 2004). With regards to the middle ear pressure, quite a few studies have found that there is no age related changes. (Uchida et al., 2000; Stenklev et al., 2004). It is evident that there is gender difference exists in the acoustic admittance values in adults (Males have higher static compliance value than females) (Jerger et al., 1972; Nerbonne et al., 1978; Hall, 1979; Wiley et al., 1996). However, this gender difference does not exist in older adults (Nerbonne et al., 1978; Hall, 1979).

Majority of the studies confirm that hearing tend to decline with increasing age in both males and females (Moscicki et al., 1985). However, there is large individual variability in absolute hearing thresholds and in the amount of change with age (Gates et al., 1990). The decline in pure-tone threshold occurs throughout the life with change at a greater rate after 50 years of age (Brant & Fozard, 1990). However, the prevalence of

hearing loss is higher in older adults. In individuals above 60 years, at least 41 % are having hearing difficulties predominantly affecting higher frequencies (Gates et al., 1990; Wiley, Chappell, Carmichael, Nondahl & Cruickshanks, 2008). Similarly, changes have also been reported for the immittance and the reflexes due to the process of ageing (Nerbonne, Schow & Bliss, 1978).

Along with the pure-tone audiometry and immittance, speech perception in the older individuals have been studied extensively. All the previous studies indicate a reduced speech identification scores in both quiet and noisy conditions (Tun, 1998; Dubno, Lee, Mathews & Mills, 1997). This reduction in speech perception ability has been attributed to the changes in both the peripheral as well as the central auditory system (Dubno et al., 1997; Jerger and Chmiel, 1997).

1.1. Need for the study

Several studies have reported different prevalence rate and audiological characteristics in different population. For example, Golding et al. (2005) has estimated the prevalence rate of hearing loss to be around 76.4% in the Australian individuals aged between 54 and 99 years. Naif Al-Ruwali et al. (2010) in a cross sectional study in the Saudi Arabian population (500 subjects with age range of 46 to 75years), reported higher occurrence of hearing loss in older individuals (10.17% in subjects with age 46 to 50 & 38.3% in subjects with age 71 to 75). Ries (1982) reported a prevalence of 30 % in people aged 65-74 years. Framingham Heart Study (Moscicki, 1985; Gates et al., 1990) reported occurrence of hearing loss to be around 42-47 % in the individuals aged above 65 years. Similarly, Cruickshanks (1998) reported 45.9% prevalence of hearing loss in

individuals aged between 48-92 years. Stig Arlinger (1991) reported that elderly subjects aged above 60 years with moderately sloping hearing loss vary in audiological characteristics other than the pure tone thresholds. Another population based study done by Wiley et al in 2005 in the city of Wincosin, U.S.A reported significant changes in the peak compensated static acoustic admittance, the tympanogram width, the equivalent ear canal volume and the tympanometric peak pressure among 2535 participants between the age range of 48 to 92 years.

All the above mentioned studies have reported the prevalence and audiological characteristics in western population. However, there is a dearth of studies in Indian population regarding the prevalence and audiological characteristics in presbycusis individuals. As, it has been reported that the different audiological findings can vary from one race to other, it is essential to report these findings in Indian population.

1.2. Aim of the study

The present study aimed to estimate the prevalence of hearing loss and audiological characteristics of presbycusis in the individuals with ear and hearing related problems who visited All India Institute of Speech and hearing, Mysore, during July, 2013 to April, 2014.

1.3. Objectives of the study

The objectives of this study were to estimate the prevalence rate of hearing loss and report the different audiological characteristics in the individuals (aged above 60 years) who reported with the ear or hearing complaint to Department of Audiology, All India Institute of Speech and Hearing, Mysore between July 2013 and April 2014.

Chapter 2

REVIEW OF LITERATURE

Hearing Impairment has major financial, social and psychological impacts on a majority of communities. It is one of the most frequent chronic conditions which affects the elderly populations, with a prevalence rate of 30 to 46% in various populations. Many of the studies indicate that hearing loss is strongly age related. According to Ries (1982); Pleis and Coles (2003), about 16% of the adults in the United Sates have some type of hearing difficulty. They also reported that hearing loss is the third most commonly reported chronic disorder in individuals more than 65 years of age, after arthritis and hypertension. By 70 years of age, approximately 30% of the individuals become hearing impaired and by 80 years of age, 50% of the population attains hearing impairment (Desai, Pratt, Lentzner & Robinson, 2001). Studies have also indicated that the hearing loss among the elderly population in the age range of 45 to 69 is also increasing, particularly in males (Wallhagen, Strawbridge, Cohen & Kaplan, 1997). In most of the studies males are reported to have more hearing related problems than females consistently, regardless of race. Also hearing impairment is more reported in white than black adults (Desai et al., 2001; Pleis & Lethbridge-Cejku, 2006). Thus the prevalence of hearing impairment varies by both race and ethnicity. The National Health Interview Survey (1999) reported that the elderly African and Asian decent experienced less hearing problems (20.1% and 17.2% respectively) than the whites or the native Americans (17.2% and 20.1% respectively). Also 15% of the non-Hispanic white adults, 6% of Hispanic white adults and 6% of non-Hispanic black adults reported some form of difficulty in hearing. The National Health Interview Survey (2005) also reported a similar

pattern of results. Hearing loss leads to frustration, increasing dependency, social isolation and the need for support services, earlier nursing home placement and hospital care. A clinical study done by Naif Al Ruwali et al. in 2010 tried to ascertain the prevalence of hearing impairment and hearing complaints in the elderly Saudi Arabian population. A cross sectional study was conducted with a self administered questionnaire Hearing Handicap Inventory for the Elderly screening version HHIE-S for 500 individuals with ages that ranged from 41 to 75. This study indicated that the prevalence of hearing loss increased with age ie, 10.17% in subjects aged 46 to 50 years and 38.3% in subjects aged 71 to 75 years with a slight male predominance compared to the females (52% to 48%).

2.1. Pure-tone Audiometry

A study on evaluation of hearing loss was carried out by Agarwal et al. (2015) in city of Manipal, India. The aim of this study consisted of profiling the audiological findings of the patients, by measuring the degree of hearing loss and otoacoustic emissions to correlate the factors namely age and gender with that of hearing loss. The authors employed a cross sectional study design at a tertiary care hospital. It considered 40 patients in the age range of 18 to 50 years with no past history of head injury, ear discharge, ear surgery, otitis media, meningitis, exposure to acute/chronic noise, treatment with ototoxic drugs and presence of family history of hearing loss. The tests carried out on the subjects were pure tone audiometry, immittance evaluations and Oto Acoustic Emissions (OAE). Puretone thresholds were measured at octave frequencies from 250 to 8000 Hz for air conduction and from 250 to 4000 Hz for bone conduction using the Modified Hughson- Westlake procedure. Immittance Audiometry was

performed to rule out the presence of any middle ear pathology prior to performing the OAE test. Measurement of Transient Evoked OAE's was done at 80 dB peak sound pressure level to check the functioning of outer hair cells. The results indicated that the majority of the patients had bilateral Sensorineural Hearing Loss ranging in severity from minimal to mild degree. OAE's were found to be absent in 30% of the subjects. Thus it was concluded that age had a contributing effect on raising the hearing thresholds but gender did not show such an effect.

Allen et al. (2010) examined the presence of presbycusis in 960 subjects (552 female, 408 male, 18–92 years). Each had 30 measures of peripheral hearing sensitivity: pure tone audiograms for right and left ears from 250 to 8000 Hz and DPOAE for each ear with F2 mean = 1–6.4 kHz. The result indicated that the hearing phenotypes did not naturally separate into discrete classes of presbycusis. A heuristic division of this continuum resulted in various classes of presbycusis which vary in their degree of Sloping or Flat hearing loss, which suggests that the sub-types of presbycusis which were reported earlier arise from the categorical segregation of a heterogeneous and continuous distribution. Further, most phenotypes lie intermediate to the extremes of either Flat or Sloping hearing loss, indicating that if audiometric configuration can predict presbycusis etiology, then a mixed origin is the most prevalent.

Arvin et al. (2013) reported that inclusion of high frequency audiometry (> 8 k Hz) in the test protocol can tap the early occurrence of presbycusis. The study consisted of adults in the age range of 20 to 49 years. High frequency pure tone audiometry was carried out for them (up to 16 k Hz). The subjects were grouped into three different categories of 10 years of age range. The authors reported the presence of symmetrical

high frequency sensorineural hearing loss. The result proved that, a symmetrical high frequency sensorineural hearing loss was present significantly as early as from the age group of 40 to 49 years. Thus high frequency presbycusis may occur much earlier age than previously expected.

Lee, Matthews, Dubno and Mills (2005) conducted a longitudinal study of the pure-tone thresholds in the older individuals. They obtained extended high frequency pure-tone threshold for 188 older adults including 97 males and 91 females. The aim of the study were to obtain the longitudinal changes in thresholds and the various factors affecting these changes. During the entry to the study, ages of the subjects were from 60 to 81 years. The conventional Puretone thresholds were measured at 250 to 8000 Hz during each visit and extended high frequency thresholds were also measured at 9000 to 18000 Hz every 2 to 3 years. The results revealed that the average rate at which the threshold changed were more at higher frequencies than at lower frequencies. An average rate of hearing threshold progression was found to be 1 dB per year for subjects above 60 years. The parameters which affect the rate of threshold change were found to be age, gender, and initial threshold levels. Older subjects (≥70 years) had faster rate of threshold change at 250 to 3000, 10000, and 11000 Hz than younger subjects (60 to 69 years). Also, individuals with poor initial thresholds at the low and mid frequencies, there was a faster rate of threshold change in the subsequent years.

2.2. Immittance Audiometry

Golding et al. (2007) studied the tympanometric and acoustic stapedius reflex measures in the older adults. Tympanometric peak pressure, peak compensated static

acoustic admittance (peak Y) and Acoustic Stapedius Reflex (ASR) thresholds were measured for 1565 older Australians aged 49 years and above. Tympanograms were obtained for both ears with a 226 Hz probe tone. A single positive-to-negative direction of pressure change from +200 to -200 daPa, or -400 daPa was used. Peak Compensated Static Acoustic Admittance (Peak Ytm) measures were calculated keeping the admittance value as a reference at +200 daPa for the compensated calculations, and tympanometric peak pressure was measured at the point of the maximum admittance. Acoustic stapedial reflex thresholds were obtained at the point of maximum admittance with contralateral stimulus to both ears at 500, 1000, and 2000 Hz, and with ipsilateral stimulus to both ears at 500 and 1000 Hz. No significant age and gender effects were found for the tympanometric peak pressure. However across all the age groups, the peak admittance measures decreased with age in the left ear only and were higher for males than for females. Also there was an increase in Acoustic Stapedial Reflex thresholds with ageing at selected frequencies but only when they were measured contralaterally.

Sogebi (2014) conducted a cross sectional comparative study on 103 elderly patients aged 60 and above. The objective of the study was to report the changes occured in the middle ear impedance related to ageing, and to find if there was any relation of these changes with those in the inner ear of the elderly subjects. The subjects were administered with a structured questionnaire to obtain the clinical information. Pure tone audiometry, tympanometry, and acoustic reflexes were also done. Comparative analyses were done to detect the intergroup differences between the clinico-audiometric findings and the middle ear findings through tympanograms and acoustic reflexes. The results indicate that the age-related hearing loss was present in 59.2% of the subjects, abnormal

tympanograms were present in 39.3% of the subjects and absent acoustic reflexes were present in 37.9% of the subjects. There was no correlation between the age and gender in individuals with abnormal tympanograms and absent acoustic reflexes. A large number of patients with different types and grades of age-related hearing loss were found to have abnormal tympanometric results and absent acoustic reflexes. Thus it was observed that there were some abnormalities the impedance audiometric measures of the elderly patients, which were significantly associated with the parameters related to age-related hearing loss.

Wiley et al. (1996) conducted a study to report the tympanometric findings in the older adults. The tympanometric measures such as Peak Compensated Static Admittance (Peak Ytm), Equivalent Ear Canal Volume (Vea) and Tympanometric Width (TW) were obtained for a probe frequency of 226 Hz using a positive-to-negative direction of pressure change and a measured pump speed of 600/200 daPa/sec . The subjects selected for the study were 1240 adults (2147 ears) in the age ranging between 48 to 90 years. None of the subjects reported a history of otic disease, passed an otoscopic examination, and did not have significant air-bone gap based on pure-tone audiometry. Compared to the findings for the younger adults, the tympanometric measures for the older adults in the present study showed much variability, a slightly lower mean Peak Compensated Static Acoustic Admittance (Peak Ym), and a significantly higher mean Equivalent Ear-canal Volume (Vea). Across age in the present study, Vea tended to decrease with age and Tympanometric Width (TW) tended to increase with increase in age. Compared to the measures for females, the males in the present study tended to have higher peak Ym values, higher Vea values, and slightly lower TW values.

Nondahl et al. (2013) tried to determine the changes over sixteen years in the Peak Compensated Acoustic Admittance (Peak Ytm) measurementss in the older adults through a population based study to determine whether age was associated with any change in Peak Ytm. Other tympanometric measures like Equivalent Ear-Canal Volume (Vea), Tympanometric Peak Pressure (TPP) and Tympanometric Width (TW) were also taken and analyzed. The subjects considered for the study were 3753 older adults aged between 48 to 84 years, to assess 16-year change. Tympanometric measures were taken using a 226-Hz probe tone, with a positive-to-negative direction of pressure change, and measured at a pump speed of 600/200 daPa/s. The results revealed that during the 16-year period, Peak Ytm declined at an average rate of 0.009 mmho/year (0.009/year for women, 0.007/year for men). Among the women subjects, the older subjects were associated with a greater decline in the Peak Ytm. Among the men subjects, it was associated with a change in Peak Ytm, but in a nonlinear fashion. Other tympanometric measures demonstrated a little change after 16 years. These results also demonstrated a slight degree of middle-ear stiffening after 16 years among the elderly, but it was not enough to affect the function that would influence the clinical decisions.

2.3. Oto Acoustic Emissions

Strouse, Ochs and Hall (1996) studied the effect of ageing on Distortion Product Oto Acoustic Emissions (DPOAE's). This study evaluated the contribution of age and peripheral hearing loss on the prevalence and amplitude of DPOAE's by controlling the degree of peripheral hearing loss. Twenty subjects were divided into the following four age ranges: 20 to 29 years 50 to 59 years, 60 to 69 years, and 70 to 79 years. All subjects in each group had 15 dB HL or better thresholds from 250 through 8000 Hz and normal

immittance findings. The measurement of DPOAEs was conducted by acquiring both DPOAE audiograms and a series of input/output (1/O) functions. Audiograms were collected in 12 steps per octave at the stimulus levels of 55, 65, and 75 dB SPL, with the geometric mean of fl and f2 extending from 0.5 to 8 kHz. The results indicated that the DPOAE audiograms recorded at these three intensity levels and input/output functions recorded at six discrete frequencies showed no significant differences in their amplitude or noise level between age groups. This indicates that when the degree of peripheral hearing loss is adequately controlled, there is no direct effect of advanced age on DPOAE measures.

A study done by Torre III, Cruickshanks, Nondahl, and Wiley (2003) explored the Distortion Product Oto Acoustic Emission response characteristics in older adults. The objectives of the study was to determine the amplitude and signal to noise response characteristics of the distortion product otoacoustic emission (DPOAE) and to assess the specificity DPOAE in differentiating hearing sensitivity in older adults. DPOAEs were measured in 937 subjects aged 48 to 92 yr. The DPOAE data were correlated with the pure-tone frequencies (1 k Hz to 8 k Hz) in the subjects to determine how DPOAE's differentiated normal hearing sensitivity and hearing impairment. Receiver operator characteristic analysis demonstrated that, DPOAE/ Noise ratio of -6 dB SPL at 2000 Hz, -14 dB SPL at 4000 Hz, and -22 dB SPL at 8000 Hz yielded the highest discrimination.

Bertoli and Probst (1997) studied the role of Transient-Evoked Otoacoustic Emission (TEOAE) testing in the evaluation of elderly persons. The aim of the study was to determine the qualitative and quantitative changes which occur in the TEOAEs in the older individual irrespective of hearing impairment and age. The click evoked TEOAE

were measured in 201 subjects who didn't have any middle ear abnormalities and aged between 60 to 97 years old. The result showed that Click Evoked OAEs were absent in ears with a PTA > 30 dB HL. The prevalence of CEOAEs in ears with a PTA less than or equal to 30 dB HL was 60%. Response rate became poor with advancement in hearing thresholds, but it was found that there was no effect on TEOAE level from age factor. An average amplitude of TEOAEs in elderly is reduced. Also, the response rate is reduced to 60% in comparison to results from younger subjects. This implies that ageing lead to changes in outer hair cells.

2.4. Speech Audiometry

Kirkim, Serbetcioglu, Odabasi and Mutlu (2005) investigated the communicative profile of the middle and older aged individuals with high-frequency hearing loss. A total of 300 subjects in the age range of 40 to 89 years with bilateral high-frequency hearing loss were considered for the study. All subjects were evaluated with pure tone audiometry, speech audiometry, middle ear immittance testing and TEOAE. The results indicated that the speech discrimination scores of individuals above 60 years were significantly lower than individuals in the lower age group. Thus the impact of aging on audiological measures is evident through 60 years and above.

Humes (1996) investigated the speech understanding in the elderly subjects. There were two studies conducted, where the first study compared the monaural and binaural speech-identification performance of the elderly hearing impaired subjects. The second one studied the monaural speech identification performance in the elderly by examining the contributions of hearing loss and aging to the identification of nonsense

syllables. A larger scale study was conducted in which 50 elderly persons, between the ages of 63 and 84 years, served as subjects. The speech measures ranged from closed-set identification of nonsense syllables to open-set recognition of the final word in meaningful sentences. The results of the study indicated that the patients who performed poorly in one speech task also performed poorly in the other speech tasks. It also indicated that the degree of sensorineural hearing loss affected the non-sense syllable identification. That is when the hearing loss is greater, the speech identification scores were poorer.

Humes and Roberts (1990) tried to account for the speech recognition difficulties of the hearing impaired elderly individuals and the contribution of audibility. Between group comparisons were made for three groups comprising of young normal hearing adults, normal hearing young adults with simulated sensorineural hearing loss that is equivalent to the elderly subjects and elderly hearing impaired adults. A total of 36 subjects participated in the study where, 23 of them were normal hearing young adults with the age range of 19 to 34 years and 13 of them were elderly hearing impaired individuals in the age range of 65 to 75 years. The full 11-subset version of the City University of New York (CUNY) Nonsense Syllable Test was used in the speech recognition testing. The results of the study suggested that the elderly hearing impaired individuals had more difficulty in understanding speech than the young normal hearing individuals. Also the performance of the noise masked young subjects were the same as that of the elderly hearing impaired subjects. The results also suggests that the presence of sensorineural hearing loss is a major factor for the poor speech recognition abilities in

the elderly which results in loss of sensitivity and loudness recruitment for the high frequency stimuli.

2.5. Auditory Brainstem Responses (ABR)

Martini, Comacchio and Magnavita (1991) tried to determine the characteristics of Auditory Brainstem Responses (ABR) in the elderly individuals. For this purpose, 36 healthy older individuals (18 males and 18 females) between 58 to 76 years were considered for the study. The ABR was obtained with a 0.1 millisecond, 2000 rarefaction clicks at the rate of 21.1 stimuli per second at 75 dBnHL with a filter setting of 30 to 3000 Hz. The latency-intensity function was obtained. The results revealed that even slight presbycusis can shift latency of all the ABR peaks. Also in the subjects who had more hearing loss at 4000 Hz, had more latency shifts. Thus the latency shifts depends on the degree of peripheral hearing loss, which produces a partial delay and de-synchronization of the neural discharge. The presence of a moderate high frequency hearing loss (30-35dBHL) also results in ABR abnormalities.

Ottaviani et al. (1991) measured ABR in 74 elderly subjects aged 60 to 80 years (38 males and 36 females). ABR were recorded using 2000 alternating polarity, unfiltered 0.1 ms clicks, which were presented through a TDH 49 headphone with an inter stimuli interval of 75 ms, an analysis time of 12 ms and at 70 dB nHL. The filter setting used was 50 to 3000 Hz. The absolute latency of waves I, III and V and the inter peak latency of waves III-I, V-III, V-I were measured. The mean auditory threshold of the age-related groups (I, II, III & IV) were found to be between 36 and 40 dB HL. The ABR latencies and the inter peak interval values showed a statistically significant difference between the

aged norm subjects concerning their waves III to V and V to I inter peak interval. Thus, prolonged latency of ABR peaks were seen in the elderly subjects.

Otto and McCandless (1982) studied the effects of ageing on Auditory Brainstem Responses. For this, 30 subjects who had normal hearing in the age range of 17 to 45 years, 30 elderly subjects in the age range of 60 to 80 years and 30 young subjects in the age range of 18 to 31 years with comparable sensorineural hearing loss were selected. The ABR responses were elicited using a 0.1millisecond, 1024 unfiltered clicks at the rate of 10 clicks per second at 50 and 80 dBnHL. The results suggested that, there is degradation of the waveforms in the elderly subjects compared to the younger ones. Also in the elderly subjects,the clarity of the early waves were poorer and are therefore less frequently identifiable. There was also evidence of neural conduction time delay for the elderly subjects. Thus there is an evidence of neural changes in the elderly population compared to the younger ones.

2.6. Pravalence of Presbycusis

A study done by Sogebi et al. (2014) studied the clinical charecteristics presbycusis in Nigeria. This study consisted of 69 subjects, who had presbycusis between January 2007 and December 2010 divided into five different age groups as less than 50 years, 51 to 60 years, 61 to 70 years, 71 to 80 years and more than 81 years. The results of the study indicated that, hearing loss experienced by 61 (88.4%) of the patients, tinnitus by 55 (79.7%) of the subjects, vertigo by 23 (33.3%) of the subjects, otalgia by 17 (24.6%) of the subjects, fullness in the ear by 18 (26.1%) of the subjects. The number of patients with the history of hypertension was 24 (34.8%), and 9 (13.0%) of them had

osteoarthritis. Five of the participants had normal hearing, 13 had mild hearing loss, 18 had moderate hearing loss, 16 had moderately severe hearing loss, 7 had severe hearing loss and 10 had profound hearing loss.

Indian Council of Medical Research (1997) reported the chronic morbidity profile in the elderly, which states that hearing impairment is the most common morbidity in the elderly followed by the impairment in vision. But there are variability on results across studies. A similar study conducted in the rural population of Pondicherry in 2006 reported that the prevalence of hearing impairment in the elderly population is 15.4%.

Deepthi and Kasthuri (2012) carried out a community based study among the rural elderly of South India and they have reported that 66.9% of the elderly individuals had some degree of hearing impairment. Out of them, 24.6% of them had disabling hearing impairment, 26.9% of them had combined low vision along with hearing impairment and 10.2% of them had combined blindness associated with hearing impairment. Also, as age increased there was a significant increment in the visual, hearing and combined impairments.

Roth et al. (2011) explored the prevalence of presbycusis Europe through a case review study. This included population and epidemiological studies conducted in English since 1970 with individuals in European countries aged more than 60 years. A total of 24 studies were systematically reviewed. When these data were analyzed, about 30% of the men and 20% of the women in Europe had 30 dB HL hearing loss or more by the age of 70 years, and 55% of men and 45% of women by the age of 80 years. This points to the need to use standardized procedures while conducting epidemiological data on hearing

loss. Development of the hearing loss over time with the increase in age is a major factor which determines strategies of detect and correct the hearing loss in the elderly.

Demeester et al. (2009) analyzed the prevalence of various audiogram patterns in older adults in the age range of 55 to 65 years. They collected and classified the audiograms of 1147 subjects according to the configuration of hearing loss. The variation with age and gender were correlated with different audiogram patterns. In the population, among the various configuration obtained, the flat audiograms were more frequent (37%) whereas the least common were low frequency ascending, mid frequency U-shape and mid frequency reverse U shape (All together less than 1%). In females, the 'flat' configuration was significantly more common, compared to males where the 'High frequency steeply sloping' configuration was more common.

Hilton et al. (2007) conducted a study on age related hearing loss. Authors reported that presbycusis is the major neuro-sensory deficit associated with ageing. It occurs with a pattern of sensorineural hearing loss which is predictable, which causes problems with communication along with depression and social isolation. Even though treatment options exist with the usage of hearing aids and cochlear implants, prevention by its identification and avoidance of key risk factors are the best strategies to deal with it. They also reported that presbycusis is a sensorineural loss that initially affects the high frequencies. Also, the genetic predisposition and sound exposures are probably the major risk factors. Treatment of presbycusis includes ear protection, hearing aids, and cochlear implantation. Stem cell research may also one day become a treatment option for the people with presbycusis.

Roehm et al. (2013) reported that presbycusis is a condition that can lead to irreversible age related sensorineural hearing loss. The worsening auditory function in individuals with presbycusis is characterized by an increase in the hearing thresholds, especially at the high frequencies and decreased sound localization ability, speech comprehension, and the central auditory processing which results in difficulty hearing in the noisy listening environments. The accumulation of various insults to the auditory system including noise exposures, otologic diseases, hair cell loss due to ageing, strial dysfunction, and ototoxic exposure leads to presbycusis.

Chapter 3

METHOD

The present study was conducted with an aim of obtaining the Audiological findings in elderly individual with hearing loss in Indian context. A register-based study was used to find out the prevalence of hearing loss and different audiological characteristics of the older individuals. A retrospective case analysis was carried out by reviewing the case files of those who visited Department of Audiology, All India Institute of Speech and Hearing, Mysore, presenting complaints related to ear and/or hearing loss. The case files of individuals who visited the institute for 10 months from July 2013 to April 2014 were reviewed.

In the register based analysis, the following details were obtained from the case files:

- The demographic details of the client (name, age, gender, socioeconomic status, rural/urban population, language, regional and religion background, occupation of the individual)
- The complaints of the individuals (Information like ear pain, ear discharge, tinnitus, blocking sensation, itching sensation, difficulty in hearing, difficulty in understanding speech and speech in presence of noise, giddiness, headache, nausea, associated problems, family history)
- If tinnitus was present, then information about type of tinnitus (high pitched or low pitched and continuous or intermittent) was collected.
- Duration of the hearing loss

- The medical history of the individual (Diabetes, hypertension, cardiac issues, asthma, visual difficulties, cholesterol, etc)
- The test battery used to test the individuals with presbycusis
  - Results of pure-tone audiometry (type and degree of hearing loss)
  - Immittance (Type of Tympanogram, Tympanometric Peak Pressure, Static Admittance, Ear Canal Volume)
  - Acoustic reflexometry (Acoustic Reflexes, Reflex Decay Test)
  - OAE evaluation (Type of OAE administered ie, TEOAE's, DPOAE's or Fine Structure OAE's and their results).
  - Hearing Aid Trial carried out and the type of hearing aid prescribed for them.

Based on the above details collected, the following analysis were done to find the prevalence of hearing loss and audiological characteristics in individuals aged above 60 years who reported to Department of Audiology, All India Institute of Speech and hearing, Mysore, with the symptoms related to hearing loss between July 2013 and April 2014 were tabulated by considering the following criteria.

3.1. Degree of Hearing Loss

The degree of hearing for these subjects were classified from hearing within normal limits to profund hearing loss based on the Puretone Average(Goodman's Classification) and it's correlation with the Speech tests. The subjects with Puretone average ≤15dB was classified as having hearing sensitivity within normal limits, those with 16 to 25dB as having minimal hearing loss, those with 26 to 40dB as having mild hearing loss, those with 41 to 55dB as having moderate hearing loss, those with 56 to 70

dB as having moderately severe hearing loss, those with 71 to 90dB as having severe hearing loss and those with >90dB as having profound hearing loss.

3.2. Type of Hearing Loss

The type of hearing loss for the subjects profiled were done on the basis of both air and bone conduction thresholds and based on the air bone gap. The subjects whose both air and bone conduction thresholds were affected and with the air bone gap ≤10 dB were classified as having Sensorineural Hearing Loss. The subjects whose air conduction threshold was affected and with normal bone conduction thresholds were classified as having Conductive Hearing Loss. And the subjects whose both air conduction and bone conduction thresholds were affected and with air bone gap more than 10 dB were classified as having Mixed Hearing Loss.

3.3. Immittance and Reflexometry

In the immittance results the type of tympanogram was classified based on the tympanometric peak pressure and the static admittance. A tympanogram was classified as A type when the tympanometric peak pressure was within -100 to +60 daPa and the static admittance was within 0.5 to 1.75 mmho, As type when the tympanometric peak pressure was within -100 to +60 daPa and the static admittance was less than 0.5 mmho, B type when the tympanogram was flat and the compliance could not be stabilized, Ad type when the tympanometric peak pressure was between -100 to +60 daPa and the static admittance was more than 1.75 mmho and C type when the tympanometric peak pressure was less than -100 daPa.

3.4. Oto Acoustic Emissions

The Oto Acoustic Emissions (OAE) were considered to be present:

- When the OAE signal amplitude is equal to more than 3dB
- When the signal to the noise ratio is equal to or more than 6dB
- When the reproducibility is equal to or more than 90%

3.5. Auditory Brainstem Responses

Auditory Brainstem Responses (ABR) were considered to be present, when there is a reproducible or replicable Vth peak present at a particular intensity level within the particular latency limits. Absence of Wave V was considered to be an absent ABR at any intensity.

3.6. Hearing Aid Fitment

The subjects who were found to have a degree of hearing loss that required the usage of amplification devices, were sentenced for free field functional gain testing with the hearing aids. Free field puretone testing, questions, word identification and tolerance checks were done with the subjects wearing the hearing aid. According to the subject's need and convenience, a suitable body Level or behind the Ear hearing aids were prescribed to the individuals.

Chapter-4

RESULTS

The present study was conducted with an aim of documenting the various audiological findings in older individuals who visited the Department of Audiology at All India Institute of Speech and Hearing during July, 2013 to April, 2014. A total number of 1801 clients aged above 60 years visited the Department of Audiology during July 2013 to April 2014 period. Out of the 1801 clients, the data could be collected for 1053 clients, due to loss of several files. The age range of the participants who visited the department was between 60 to 98 years. Out of the 1053 participants, 711 participants were male subjects and 342 participants were female subjects. The various audiological test results which were documented for these clients are Puretone Audiometry, Immittance test results, Oto Acoustic Emissions, Auditory Brainstem Responses and Hearing Aid fitment.

4.1. Categorization of degree of hearing loss

The categorization of degree of hearing loss was done by dividing the subjects into four age groups namely 60 to 70 years, 70 to 80 years, 80 to 90 years and more than 90 years.

4.1.1. Age group of 60 to 70 years

The number of male subjects who had hearing sensitivity within normal limits in their right ear was found to be 13 and who had hearing sensitivity within normal limits in

their left ear were found to be 8. The number of female subjects who had hearing sensitivity within normal limits in their right ear was found to be 11 and who had normal hearing sensitivity in their left ear was found to be 10.

The number of male subjects who had minimal hearing loss in their right ear was found to be 30 and the number of male subjects who had minimal hearing loss in their left ear was found to be 34. The number of female subjects who had minimal hearing loss in their right and left ear was found to be 19 and 29 respectively.

The number of male subjects who had mild hearing loss in their right ear and left ear were found to be 77 and 57 respectively. The number of female subjects who had mild hearing loss in their right and left ear were found to be 46 and 36 respectively.

The number of male subjects who had moderate hearing loss in their right ear and left ear were found to be 73 and 72 respectively. The number of female subjects who had moderate hearing loss in their right and left ear were found to be 44 and 51 respectively.

The number of male subjects who had moderately severe hearing loss in their right and left ear were found to be 84 and 84 respectively. The number of female subjects who had moderately severe hearing loss in their right and left ear were found to be 45 and 43 respectively.

The number of male subjects who had severe hearing loss were found to be 86 and 74 respectively. The number of female subjects who had severe hearing loss in their right and left ear were found to be 39 and 27 respectively.

The number of male subjects who had profound hearing loss in their right and left ear were found to be 36 and 44 respectively. The number of female subjects who had profound hearing loss in their right and left ear were found to be 14 and 23 respectively.

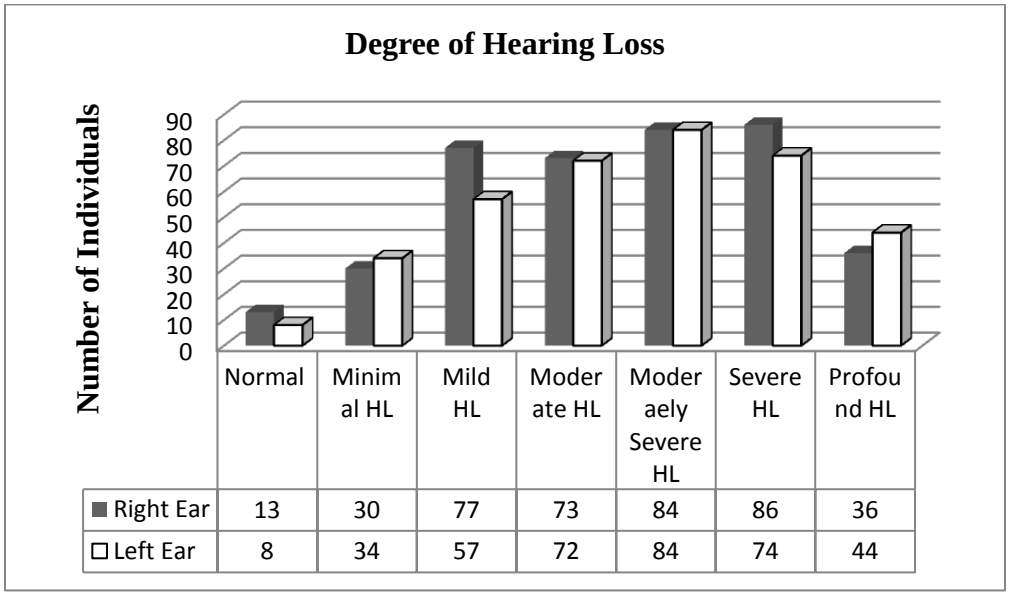


Figure 4:1. Figure showing the distribution of degree of hearing loss in males

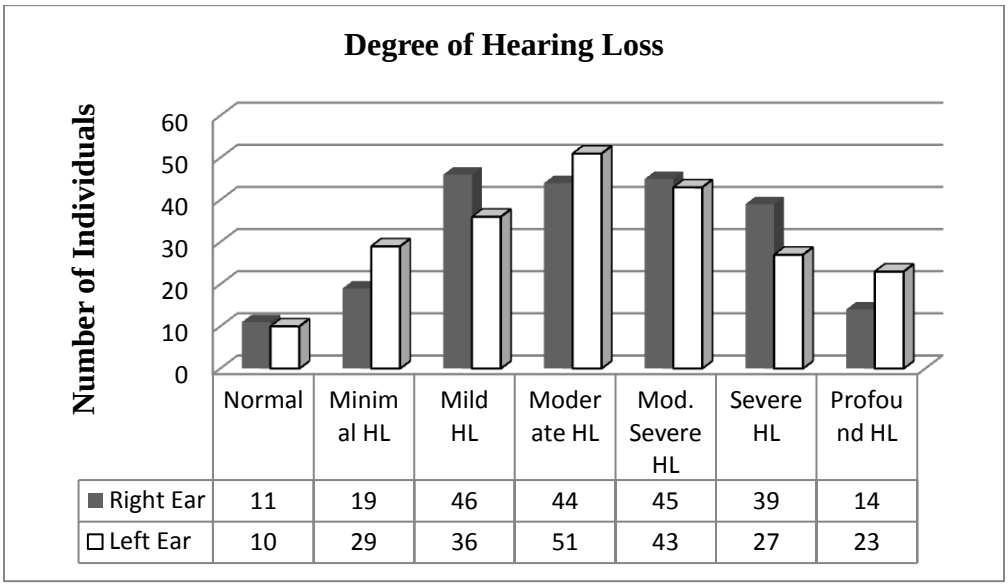


Figure 4:2. Figure showing the distribution of degree of hearing loss in females

4.1.2. Age group of 70 to 80 years

In this age group none of the male subjects had normal hearing sensitivity in either of the ear. The number of female subjects who had hearing sensitivity within normal limits in their right ear was found to be 1 and who had normal hearing sensitivity in their left ear was also found to be 1.

The number of male subjects who had minimal hearing loss in their right ear was found to be 2 and the number of male subjects who had minimal hearing loss in their left ear was found to be 6. The number of female subjects who had minimal hearing loss in their right was found to be 3 and no female subjects were found to have minimal hearing loss in their left ear.

The number of male subjects who had mild hearing loss in their right ear and left ear were found to be 34 and 28 respectively. The number of female subjects who had mild hearing loss in their right and left ear were found to be 6 and 10 respectively.

The number of male subjects who had moderate hearing loss in their right ear and left ear were found to be 67 and 71 respectively. The number of female subjects who had moderate hearing loss in their right and left ear were found to be 32 and 27 respectively.

The number of male subjects who had moderately severe hearing loss in their right and left ear were found to be 76 and 82 respectively. The number of female subjects who had moderately severe hearing loss in their right and left ear were found to be 35 and 31 respectively.

The number of male subjects who had severe hearing loss was found to be 34 and 36 respectively in right and left ear respectively. The number of female subjects who had severe hearing loss in their right and left ear were found to be 16 and 15 respectively.

The number of male subjects who had profound hearing loss in their right and left ear were found to be 20 and 17 respectively. The number of female subjects who had profound hearing loss in their right and left ear were found to be 9 and 8 respectively.

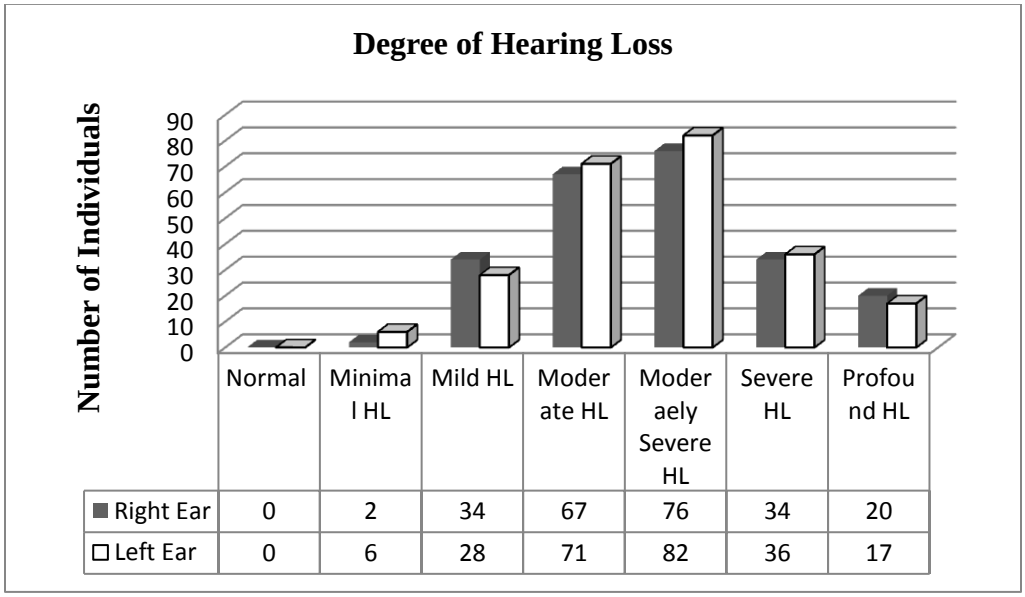


Figure 4:3. Figure showing the distribution of degree of hearing loss in males (70-80 Years)

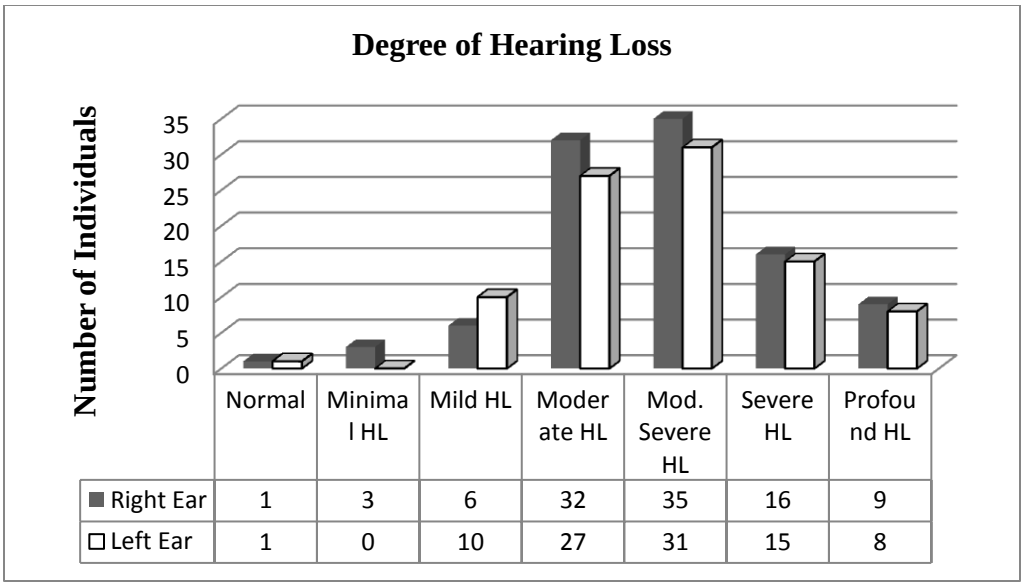


Figure 4:4. Figure showing the distribution of degree of hearing loss in females (70-80 Years)

4.1.3. Age group of 80 to 90 years

The number of male subjects who had hearing sensitivity within normal limits in their right ears were found to be 1 and none of the subjects had hearing sensitivity within normal limits in their left ear. None of the female subjects were found to have normal hearing sensitivity in any of their ears in this age group.

The number of male subjects who had minimal hearing loss in their right ear was found to be 2 and the number of male subjects who had minimal hearing loss in their left ear was found to be 3. None of the female subjects were found to have minimal hearing loss in any of their ears in this age group.

The number of male subjects who had mild hearing loss in their right ear and left ear were found to be 5 and 4 respectively. The number of female subjects who had mild hearing loss in their right were found to be 1 and none of them had mild hearing loss in their left ear respectively.

The number of male subjects who had moderate hearing loss in their right ear and left ear were found to be 27 and 17 respectively. The number of female subjects who had moderate hearing loss in their right and left ear were found to be 11 and 8 respectively.

The number of male subjects who had moderately severe hearing loss in their right and left ear were found to be 27 and 32 respectively. The number of female subjects who had moderately severe hearing loss in their right and left ear were found to be 11 and 12 respectively.

The number of male subjects who had severe hearing loss were found to be 20 and 11 respectively. The number of female subjects who had severe hearing loss in their right and left ear were found to be 4 and 8 respectively.

The number of male subjects who had profound hearing loss were found to be 4 and 6 respectively. The number of female subjects who had profound hearing loss in their right and left ear were found to be 4 and 3 respectively.

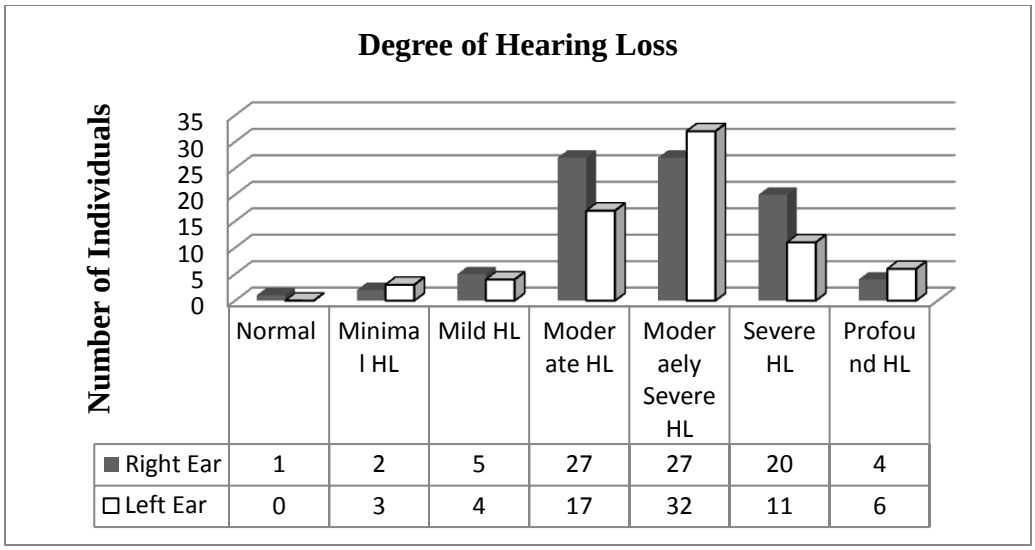


Figure 4:5. Figure showing the distribution of degree of hearing loss in males (80-90 Years)

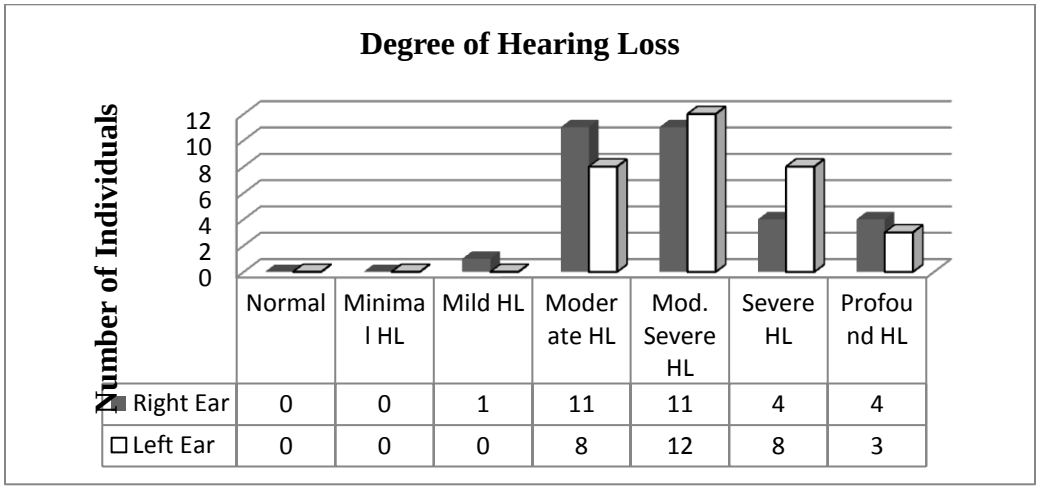


Figure 4:6. Figure showing the distribution of degree of hearing loss in males (80-90 Years)

4.1.4. Age group of more than 90 years

None of the male and female subjects had hearing sensitivity within normal limits in any of their ears in this age group. None of the male and female subjects had minimal hearing loss in any of their ears in this age group.

Also none of the male and female subjects had mild hearing loss in any of their ears in this age group. None of the male subjects had moderate hearing loss in any of their ears in this age group. The number of female subjects who had moderate hearing loss in their right and left ear were found to be 1 and 1 respectively.

The number of male subjects who had moderately severe hearing loss in their right and left ear were found to be 2 and 2 respectively. None of the female subjects had moderately severe hearing loss in any of their ears in this age group.

The number of male subjects who had severe hearing loss were found to be 2 and 2 respectively. None of the female subjects had severe hearing loss in any of their ears in this age group. The number of male subjects who had profound hearing loss were found to be 2 and 2 respectively. None of the female subjects had profound hearing loss in any of their ears in this age group.

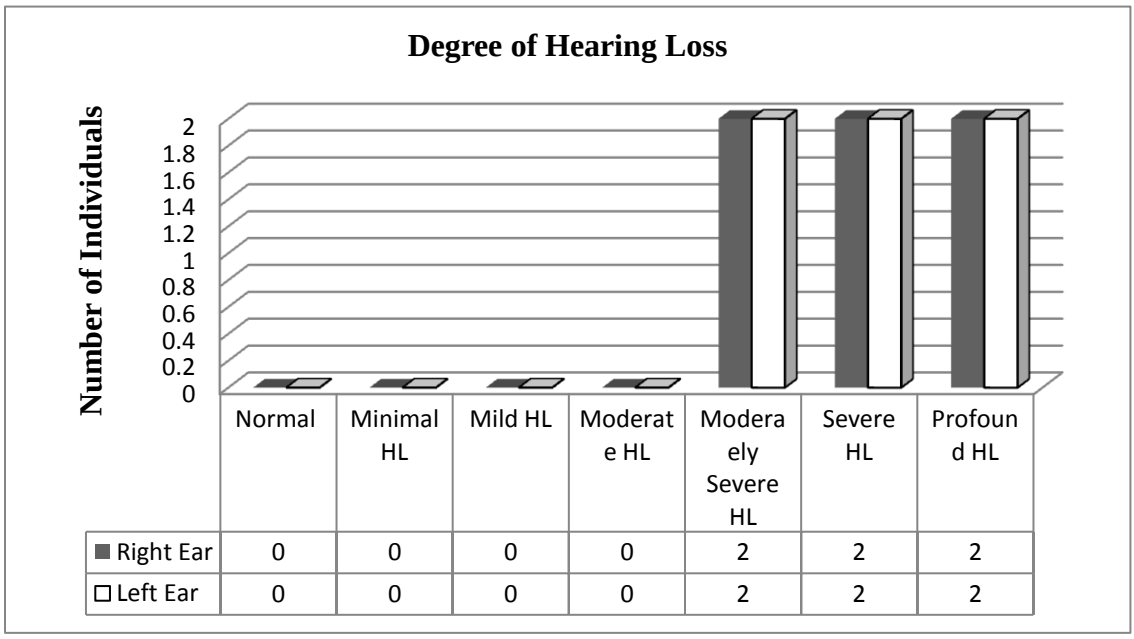


Figure 4:7. Figure showing the distribution of degree of hearing loss in males (>90 years)

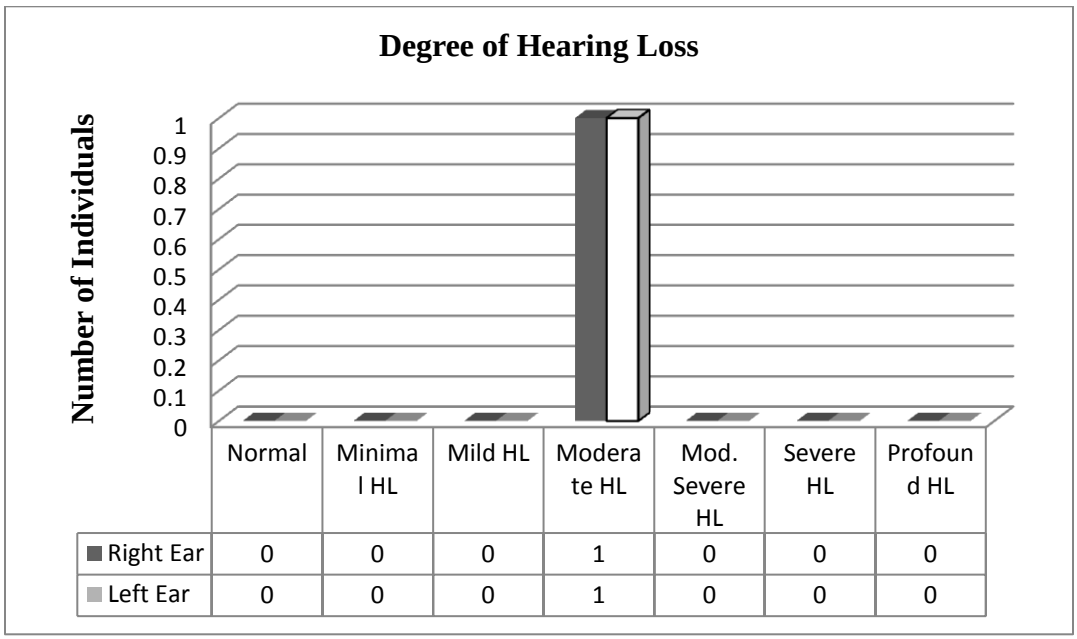
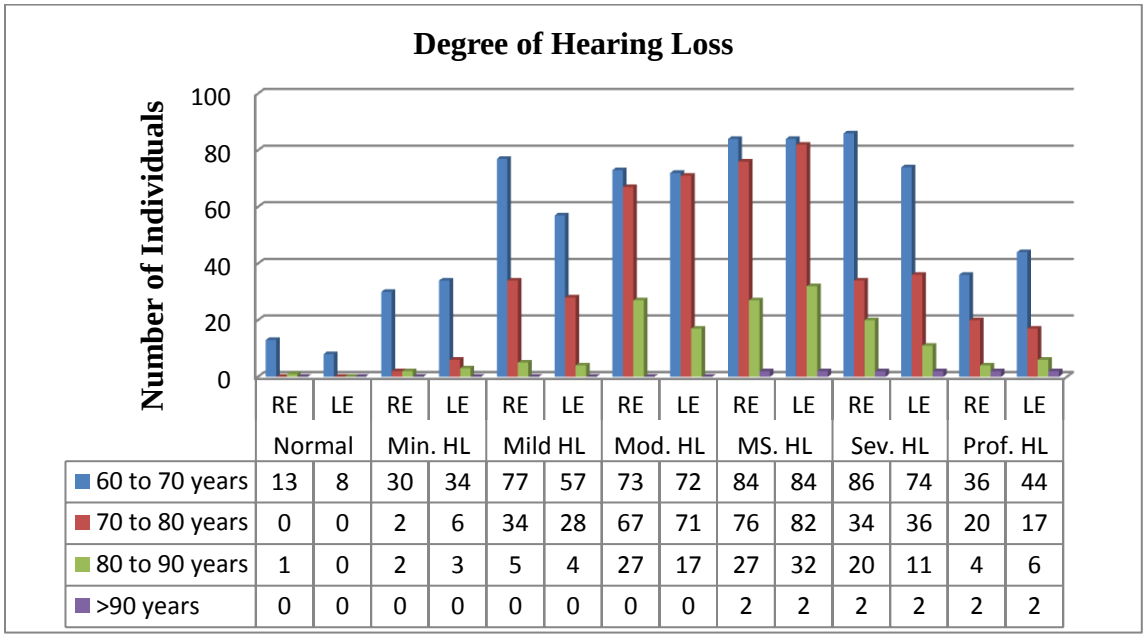


Figure 4:8. Figure showing the distribution of degree of hearing loss in females (>90 years)

Further figure 4:9 and 4:10 shows the distribution of degree of hearing loss across various age groups in males and females both. It can be seen from figure 4:9 and 4:10 that for both the males and females maximum number of subjects had moderate to moderately severe hearing loss.

Males



	RE	LE	RE	LE	RE	LE	RE	LE	RE	LE	RE	LE	RE	LE
	Normal		Min. HL		Mild HL		Mod. HL		MS. HL		Sev. HL		Prof. HL	
60 to 70 years	13	8	30	34	77	57	73	72	84	84	86	74	36	44
70 to 80 years	0	0	2	6	34	28	67	71	76	82	34	36	20	17
80 to 90 years	1	0	2	3	5	4	27	17	27	32	20	11	4	6
>90 years	0	0	0	0	0	0	0	0	2	2	2	2	2	2

Figure 4:9. Distribution of degree of hearing loss in males across different age group

Females

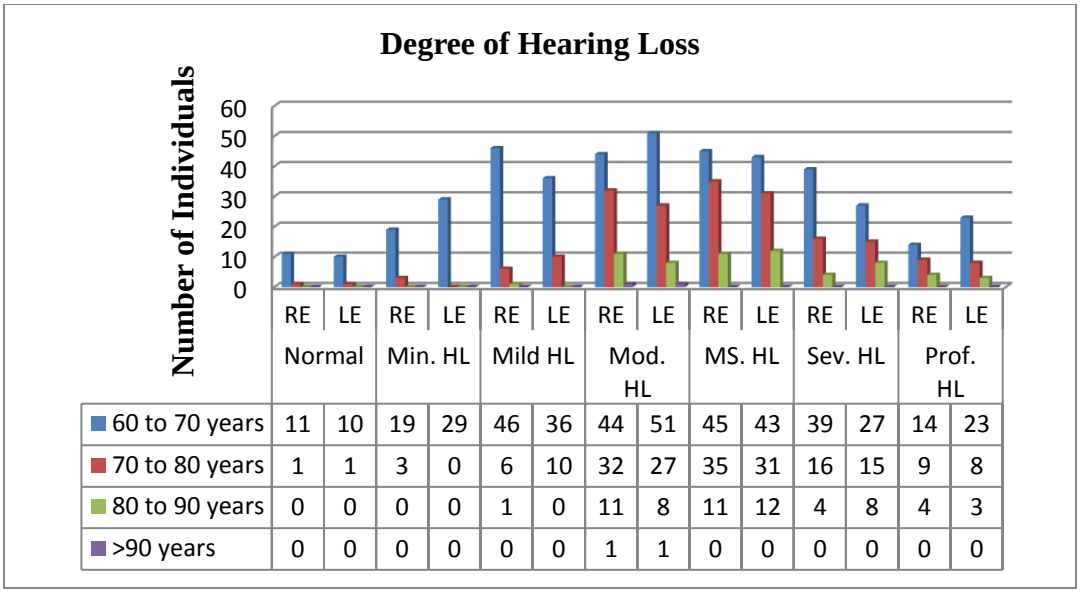


Figure 4:10. Distribution of degree of hearing loss in males across different age groups

4.2. Type of Hearing Loss

The categorization of degree of hearing loss was done by dividing the subjects into four age groups namely 60 to 70 years, 70 to 80 years, 80 to 90 years and more than 90 years.

4.2.1. Age group of 60 to 70 years

The number of male subjects who had Sensorineural Hearing Loss in their right ear and left ear were found to be 191 and 177 respectively. The number of female subjects who had Sensorineural Hearing Loss in their right ear and left ear were found to be 95 and 99 respectively.

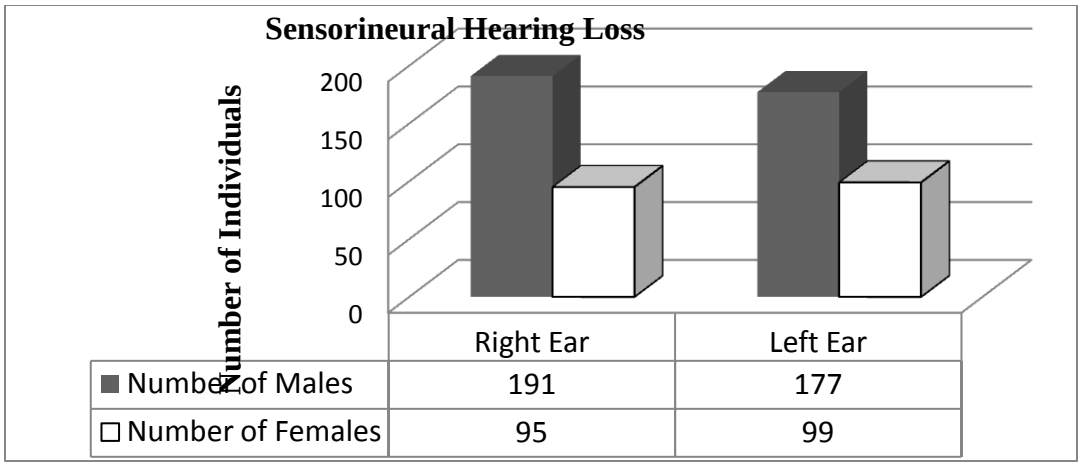


Figure 4:11. Distribution of males and females having sensorineural hearing loss (60-70 years)

The number of male subjects who had Conductive Hearing Loss in their right ear and left ear were found to be 17 and 11 respectively. The number of female subjects who had Conductive Hearing Loss in their right ear and left ear were found to be 18 and 12 respectively.

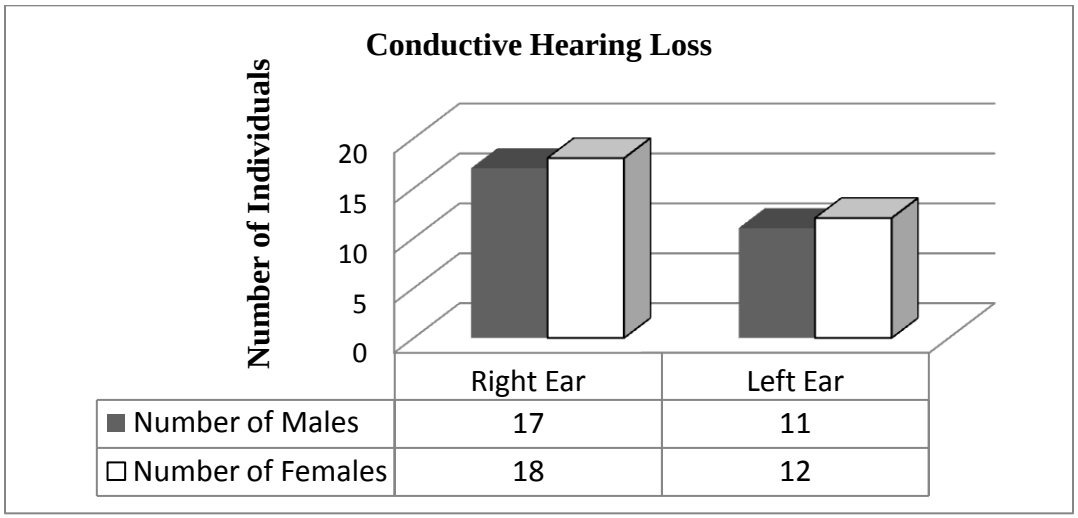


Figure 4:12. Distribution of males and females having conductive hearing loss (60-70 years)

The number of male subjects who had Mixed Hearing Loss in their right ear and left ear were found to be 87 and 99 respectively. The number of female subjects who had Mixed Hearing Loss in their right ear and left ear were found to be 56 and 46 respectively.

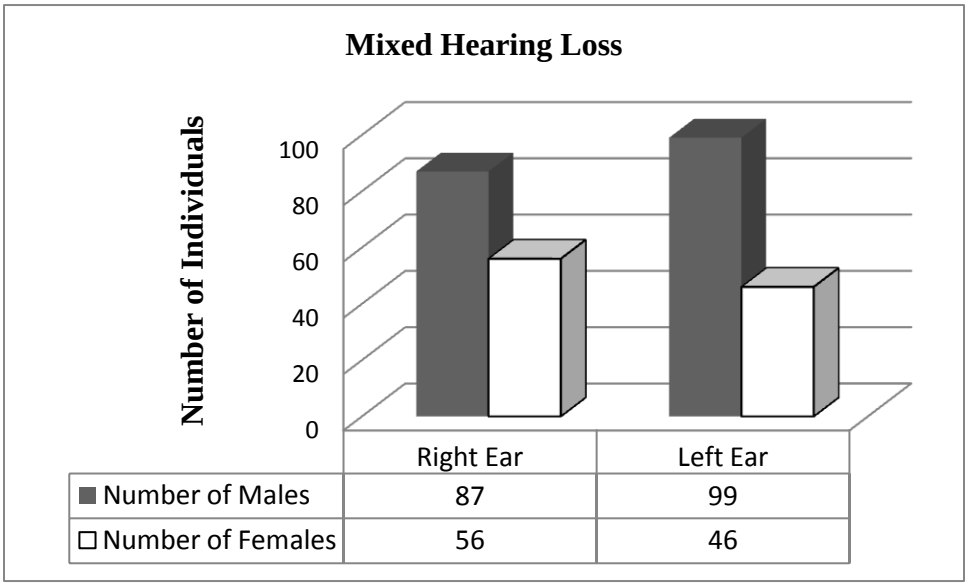


Figure 4:13. Distribution of males and females having mixed hearing loss (60-70 years)

4.2.2. Age group of 70 to 80 years

The number of male subjects who had Sensorineural Hearing Loss in their right ear and left ear were found to be 149 and 148 respectively. The number of female subjects who had Sensorineural Hearing Loss in their right ear and left ear were found to be 58 and 59 respectively.

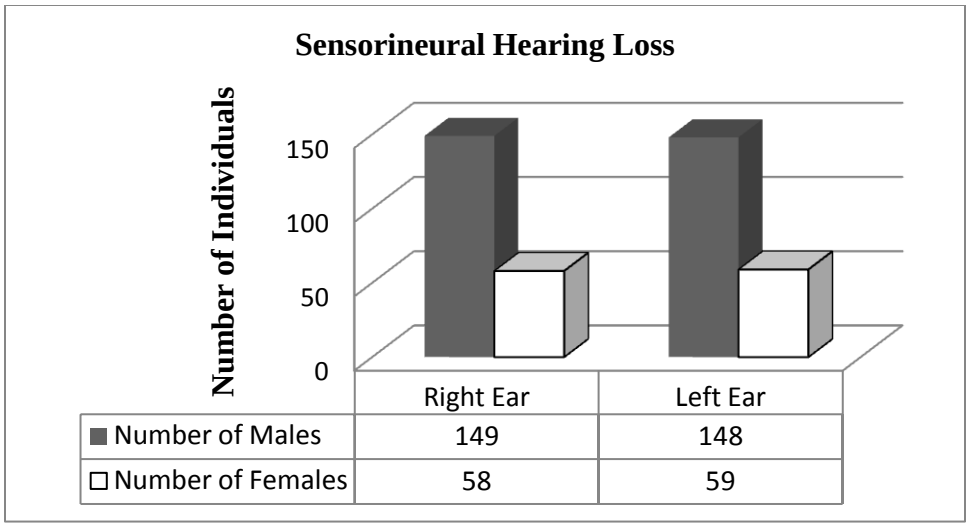


Figure 4:14. Distribution of males and females having sensorineural hearing loss (70-80 years)

The number of male subjects who had Conductive Hearing Loss in their right ear and left ear were found to be 18 and 18 respectively. The number of female subjects who had Conductive Hearing Loss in their right ear and left ear were found to be 1 and 2 respectively.

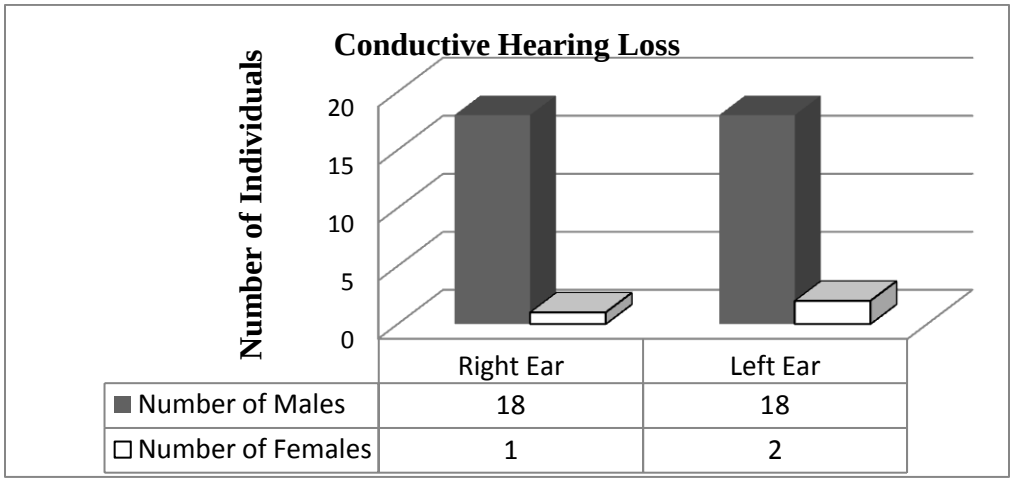


Figure 4:15. Distribution of males and females having conductive hearing loss (70-80 years)

The number of male subjects who had Mixed Hearing Loss in their right ear and left ear were found to be 44 and 51 respectively. The number of female subjects who had Mixed Hearing Loss in their right ear and left ear were found to be 21 and 23 respectively.

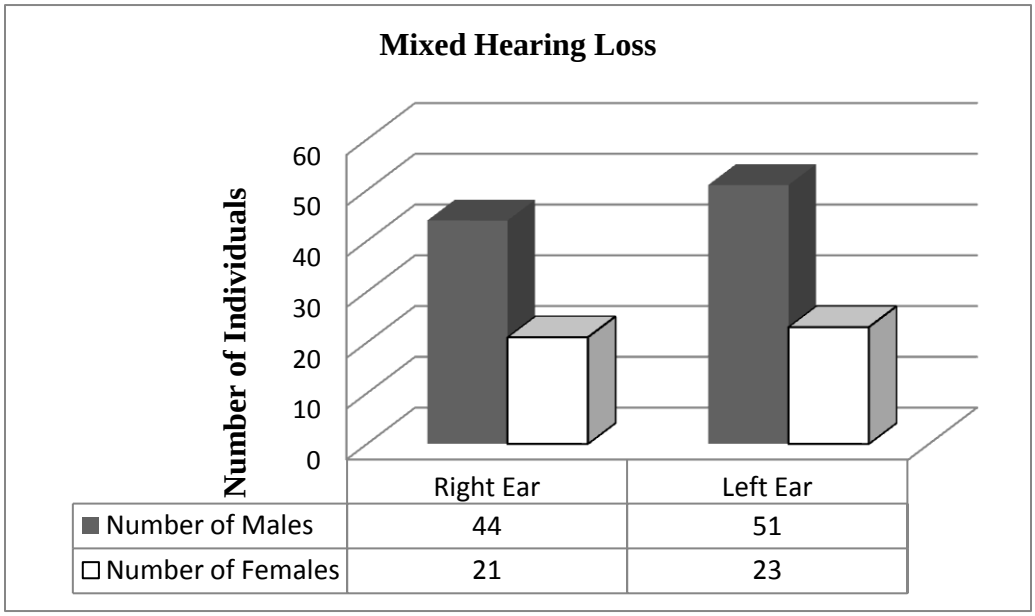


Figure 4:16. Distribution of males and females having mixed hearing loss (70-80 years)

4.2.3. Age group of 80 to 90 years

The number of male subjects who had Sensorineural Hearing Loss in their right ear and left ear were found to be 62 and 54 respectively. The number of female subjects who had Sensorineural Hearing Loss in their right ear and left ear were found to be 22 and 21 respectively.

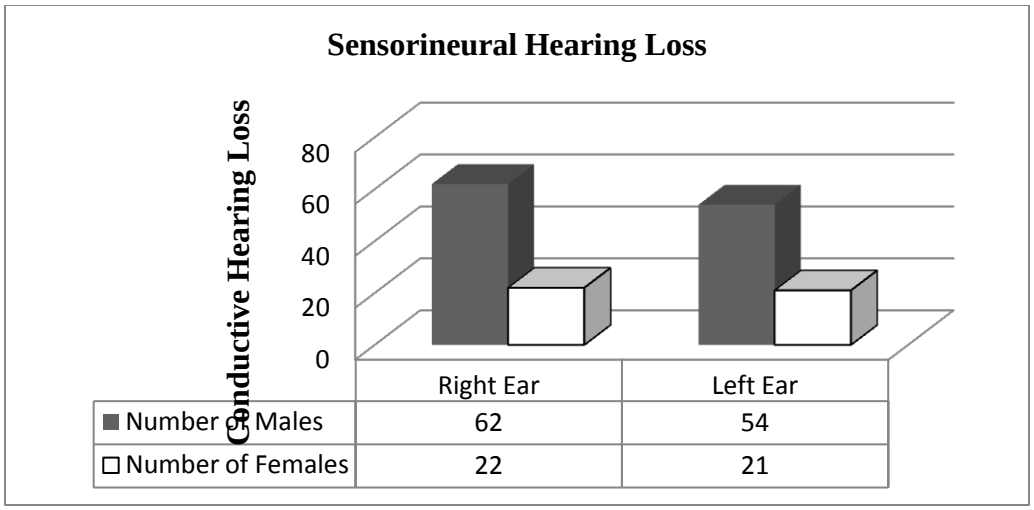


Figure 4:17. Distribution of males and females having sensorineural hearing loss (80-90 years)

The number of male subjects who had Conductive Hearing Loss in their right ear was found to be 1 and none of the subjects in this age group had Conductive hearing loss in their left ear. The number of female subjects who had Conductive Hearing Loss in their right ear and left ear were found to be 1 and 1 respectively.

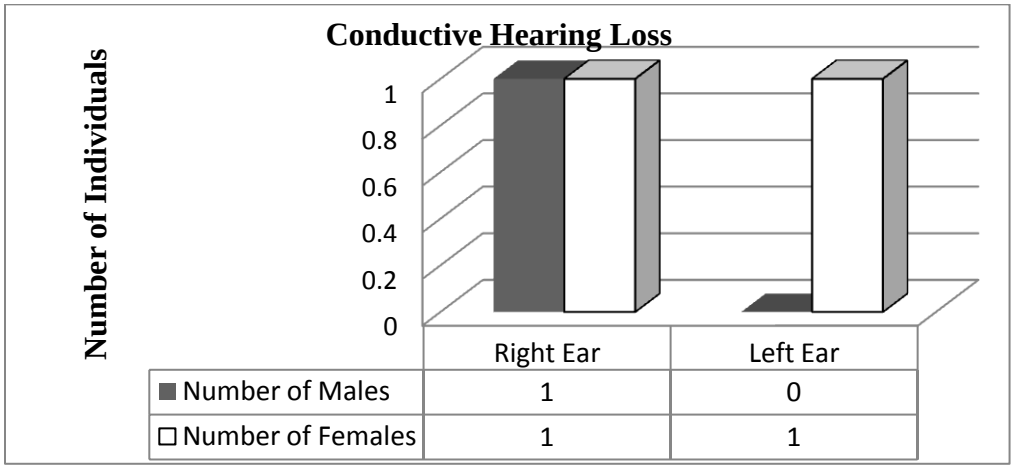


Figure 4:18. Distribution of males and females having conductive hearing loss (80-90 years)

The number of male subjects who had Mixed Hearing Loss in their right ear and left ear were found to be 14 and 10 respectively. The number of female subjects who had Mixed Hearing Loss in their right ear and left ear were found to be 4 and 6 respectively.

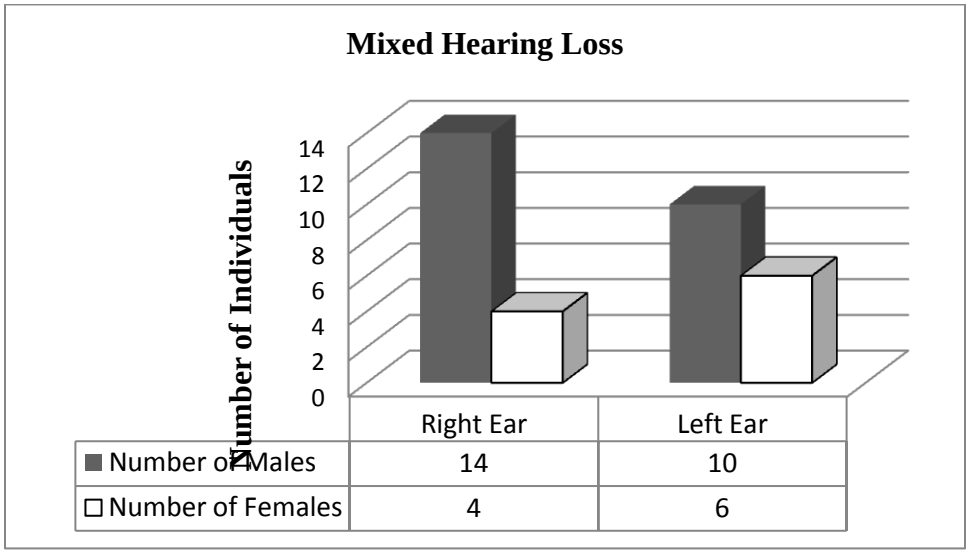


Figure 4:19. Distribution of males and females having mixed hearing loss (80-90 years)

4.2.4. Age group of more than 90 years

None of the male subjects in this age group were found to have Sensorineural, Conductive or Mixed hearing loss in any of their ears. The number of female subjects who had Sensorineural Hearing Loss in their right ear and left ear were found to be 1 and 1 respectively. Also none of the female subjects in this age group was found to have either Conductive or Mixed hearing loss in any of their ears.

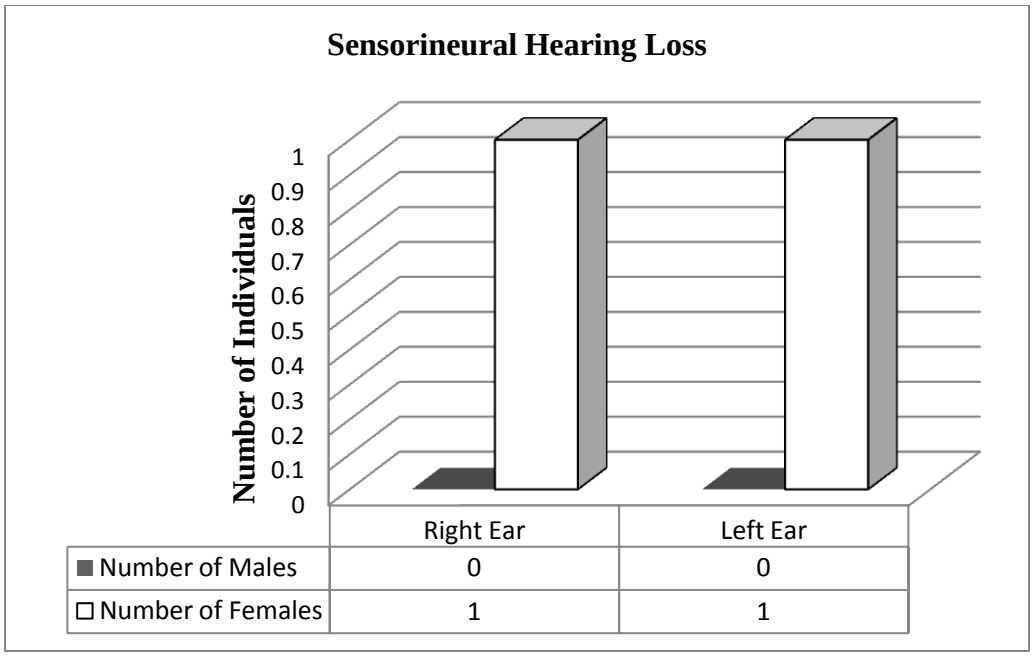


Figure 4:20. Distribution of males and females having sensorineural hearing loss (>90 years)

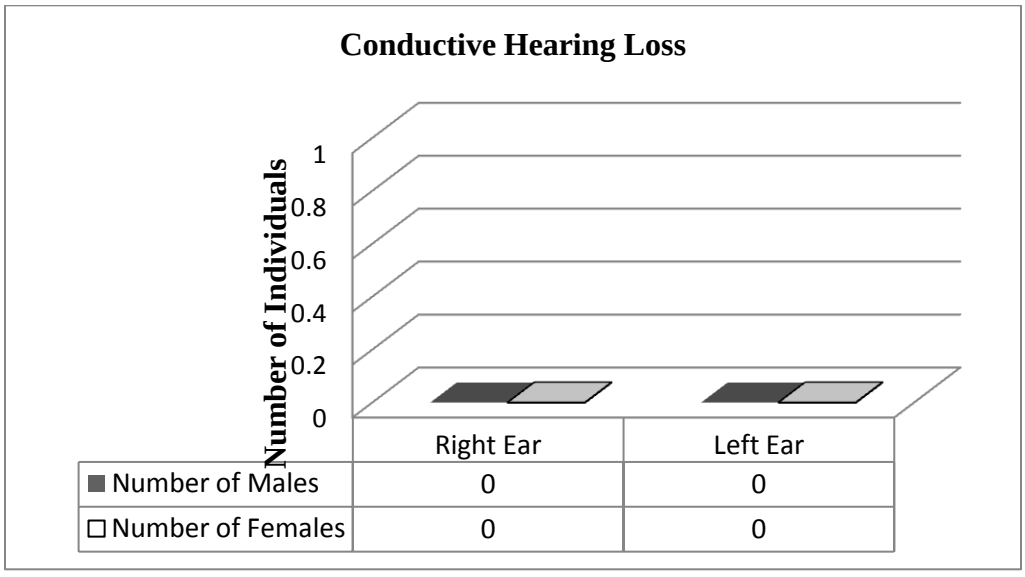


Figure 4:21. Distribution of males and females having conductive hearing loss (>90 years)

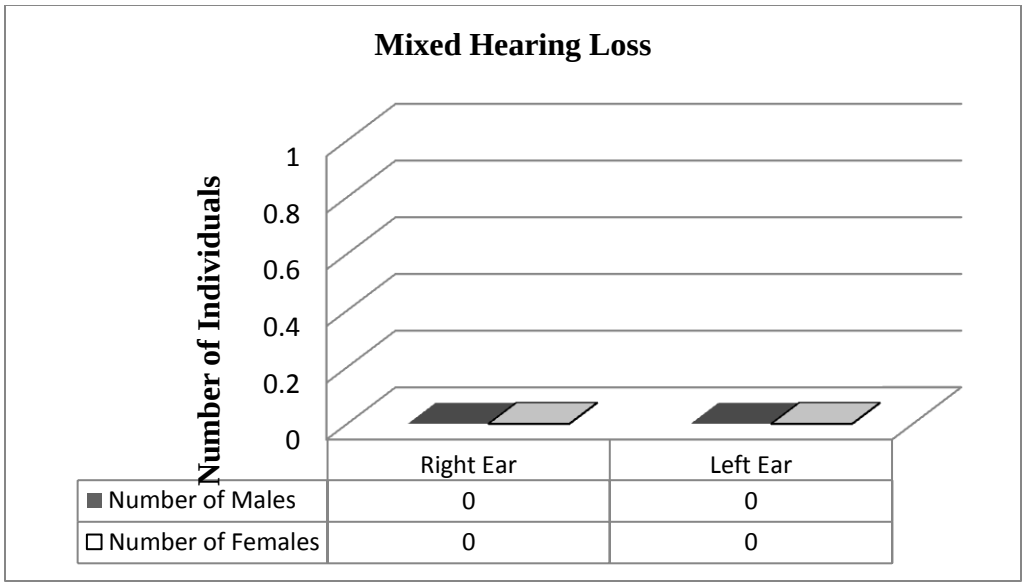
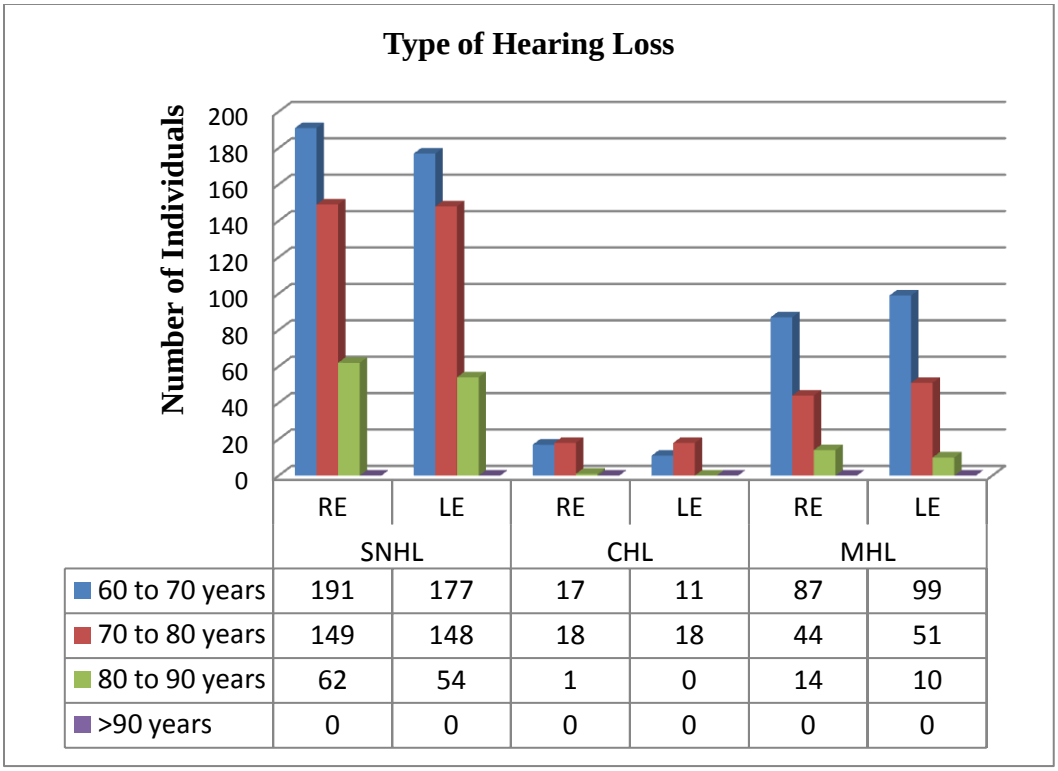


Figure 4:22. Distribution of males and females having mixed hearing loss (>90 years)

Figure 4:23 & Figure 4:24 Shows the distribution of types of hearing loss across various age groups in males and females. It can be seen from figure that for both the males and females the Sensorineural hearing loss was more prevalent followed by mixed hearing loss. Presence of conductive hearing loss in both the groups was lesser compared to sensorineural hearing loss and conductive hearing loss.

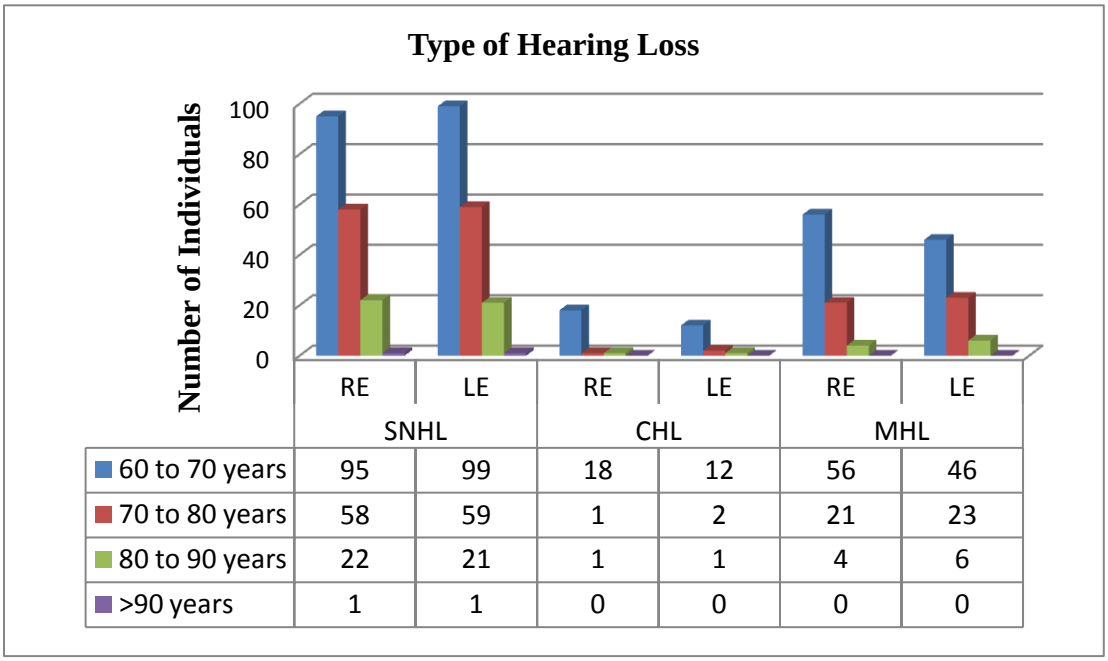
Males



	RE	LE	RE	LE	RE	LE
	SNHL		CHL		MHL	
60 to 70 years	191	177	17	11	87	99
70 to 80 years	149	148	18	18	44	51
80 to 90 years	62	54	1	0	14	10
>90 years	0	0	0	0	0	0

Figure 4:23. Distribution of different types of hearing loss in males

Females



	RE	LE	RE	LE	RE	LE
	SNHL		CHL		MHL	
60 to 70 years	95	99	18	12	56	46
70 to 80 years	58	59	1	2	21	23
80 to 90 years	22	21	1	1	4	6
>90 years	1	1	0	0	0	0

Figure 4:24. Distribution of different types of hearing loss in females

4.3. Configuration of the Slope of Audiogram

All the right and left ear audiograms were classified into three categories:

- Flat audiogram configuration
- Sloping audiogram configuration
- Rising audiogram configuration

This was according to audiometric classification by Wuyts et al., 1998, based on the earlier studies of Liu and Xu (1994) and Parving and Newton (1995). In this classification system, a Flat audiogram is defined as an audiogram where the difference between the mean of 250 or 500 Hz thresholds, the mean of 1 or 2 kHz thresholds and the mean of 4 or 8 kHz thresholds, is less than 15 dB. A sloping audiogram configuration is

defined as an audiogram where the difference between the mean of 500 Hz/1 kHz thresholds and the mean of 4 kHz/8 kHz thresholds is greater than 15 dB. A rising audiogram configuration is defined as an audiogram where the difference between the poorer low frequency thresholds and better high frequency ones is greater than 15 dB.

The statistics showed that out of the total individuals profiled, 548 of them had flat audiogram configuration, 496 of them had sloping audiogram configuration and 9 of them had rising type audiogram.

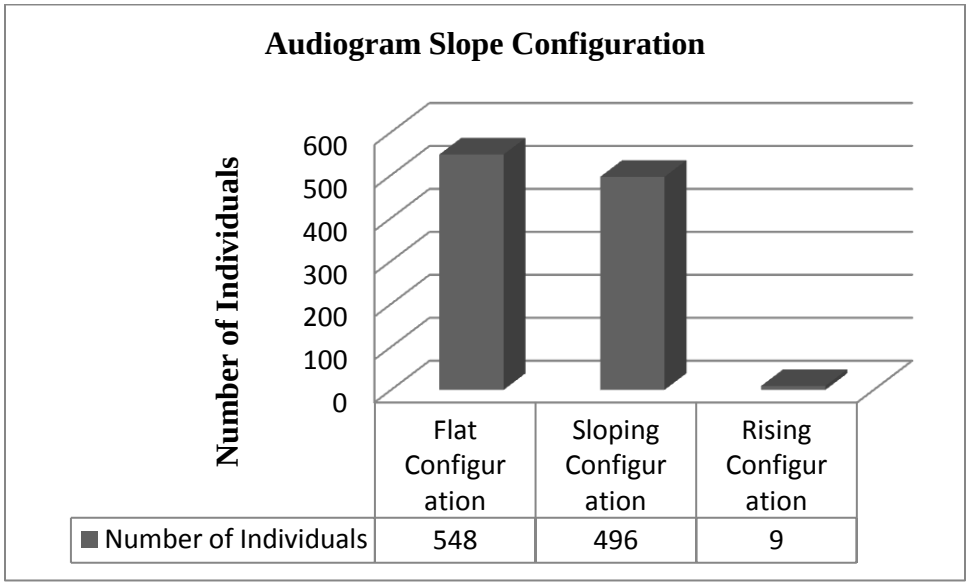


Figure 4:25. Distribution of configuration of the slope of audiogram

Among the male subjects, the number of ears with Flat audiogram configuration was found to be 667, the number of ears with sloping audiogram configuration was found to be 746 and the number of ears with rising audiogram configuration was found to be 9.

Out of the female subjects, the number of ears with Flat audiogram configuration was found to be 429, the number of ears with Sloping audiogram configuration were

found to be 246 and the number of ears with Rising audiogram configuration were found to be 9.

Figure 4:26 and 4:27 shows the frequency wise distribution of the pure tone thresholds in male and female subjects respectively. The figure has been drawn with the overall data. Figure 4:26 and 4:27 reveals that the high frequency has more hearing loss for both the males and females.

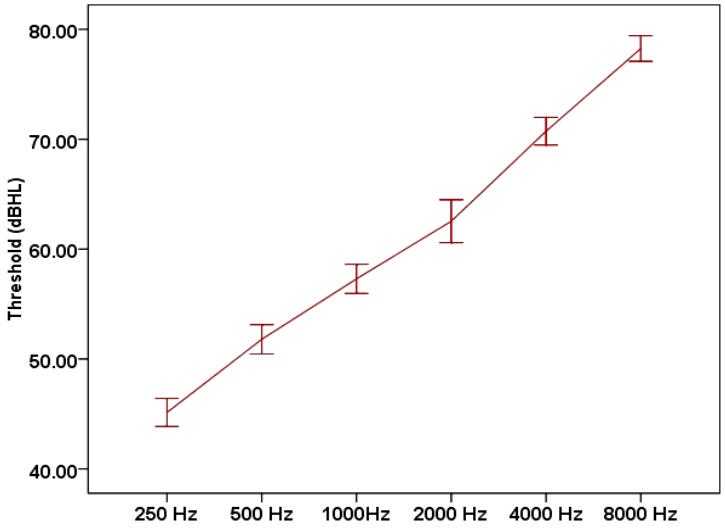


Figure 4:26. Distribution of threshold Frequency wise in males

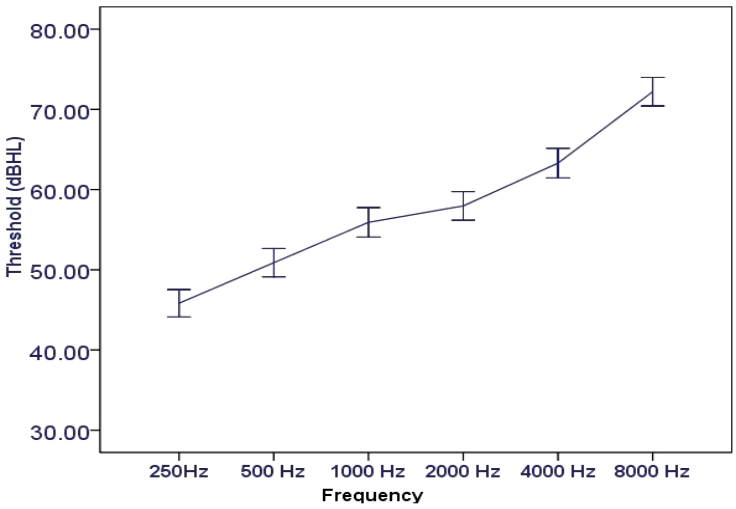


Figure 4:27. Distribution of threshold Frequency wise in females

4.4. Tympanometry and Reflexometry

From the data reviewed, it was noted that:

- 1134 ears had A type tympanogram,
- 437 ears had As type tympanogram,
- 230 ears had Ad type tympanogram,
- 260 ears had B type tympanogram and
- 22 ears had C type tympanogram.

Figure 4.26 shows the different types of tympanograms obtained in individuals older than 60 years.

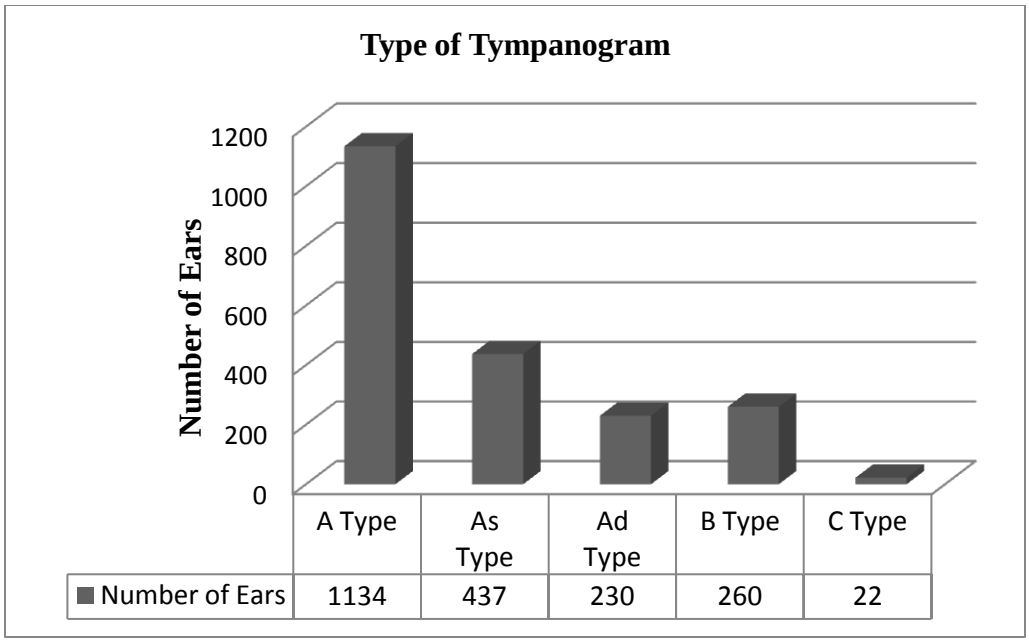


Figure 4:28. Distribution of the type of tympanogram

The Tympanometric peak pressure, Admittance values and ear canal values for males and females were calculated separately. Table 4.1 and Table 4.2 show the distribution of these data.

Table 4.1 Findings for Tympanometric Peak Pressure (TPP), Static Admittance (SA) and Ear Canal Volume (ECV) for the male subjects

	TPP	SA	ECV
Minimum Value	-375	0.1	0.3
Maximum Value	120	6.2	7.7
Mean Value	-1.58	1.02	1.55

Table 4.2. Findings for Tympanometric Peak Pressure (TPP), Static Admittance (SA) and Ear Canal Volume (ECV) for the female subjects.

	TPP	SA	ECV
Minimum Value	-310	0.1	0.5
Maximum Value	65	6.7	7.1
Mean Value	-8.63	0.94	1.49

4.4.1. Acoustic Reflexes

- Ipsilateral reflexes were present in 516 ears and absent in 1567 ears.
- The contralateral reflexes were present in 519 ears and were absent in 1564 ears.

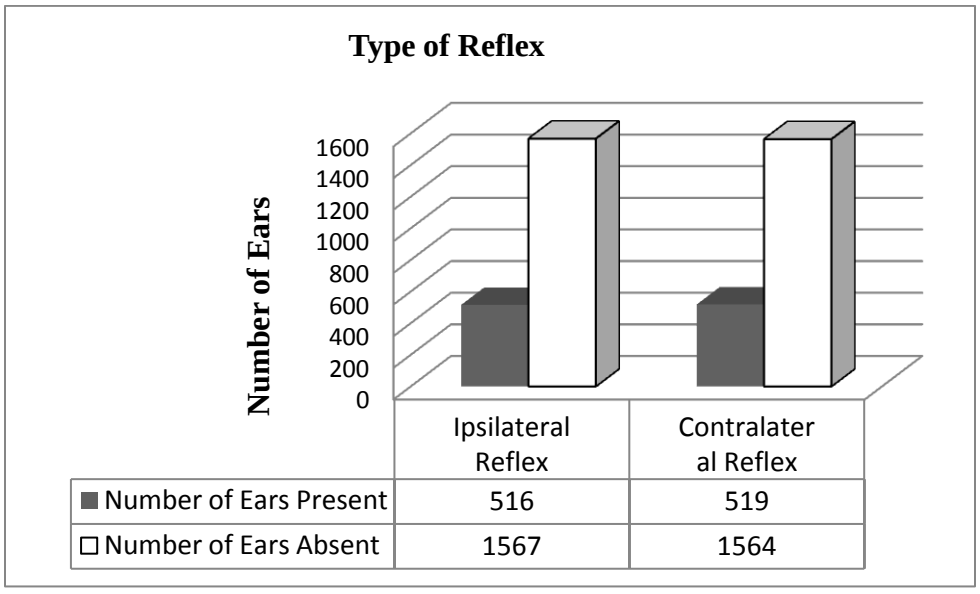


Figure 4:29.Distribution of reflex in the older subjects

4.5. Oto Acoustic Emissions (OAE's)

Total for 355 ears the otoacoustic emissions were done. From the reviewed data it was observed that OAE's were found to be present in 41 of the ears and it was absent in 314 of the ears. Figure 4.28 shows the presence /absence of otoacoustic emissions responses in older participants.

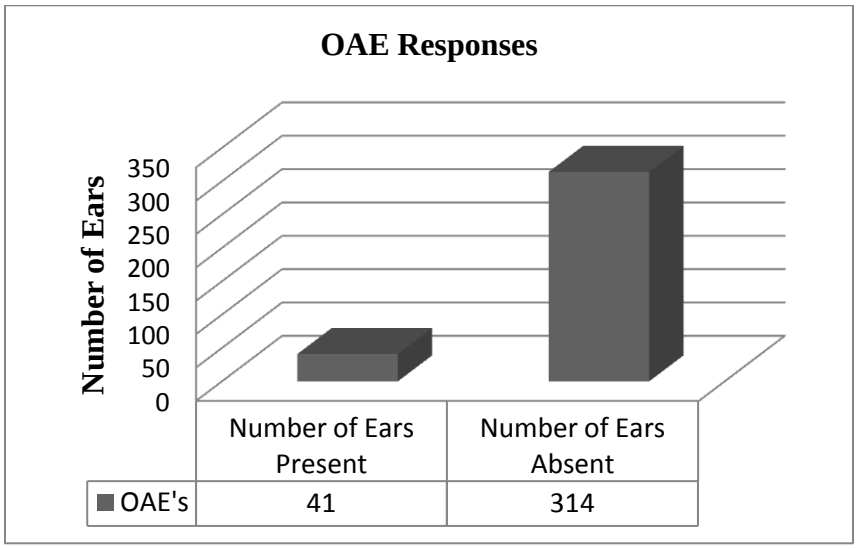


Figure 4:30. Shows the presence and absence of otoacoustic emissions responses in older participants

4.6 Auditory Brainstem Responses

The Auditory Brainstem Responses (ABR) were done for 205 ears and was found to be present in 142 ears and were found to be absent in 63 ears.

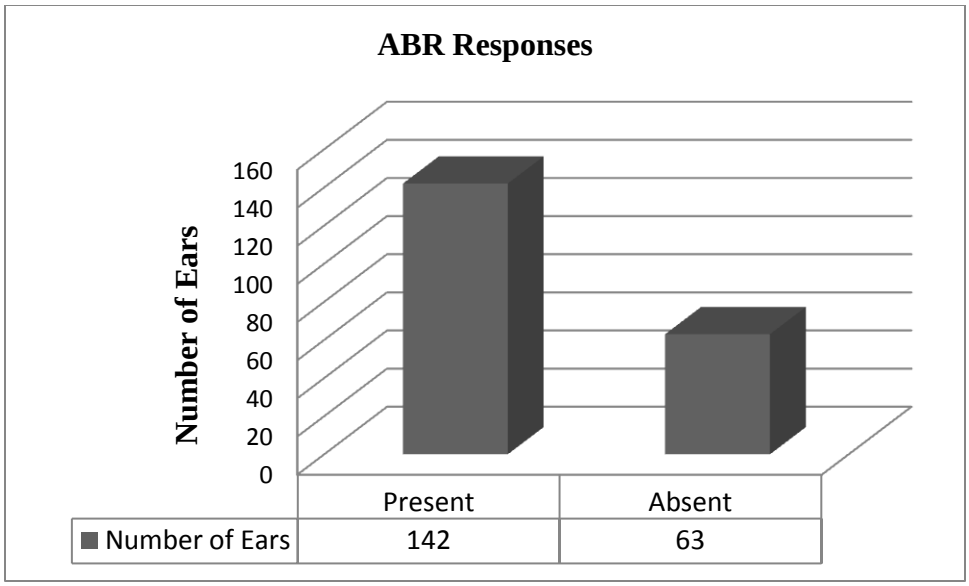


Figure 4:31. Graph showing the distribution ABR responses

4.7. The Complaints Reported by the Patients

The patients visited with a variety of complaints to the institute. The following complaints were noted down and reviewed:

- The presence of reduced hearing sensitivity
- Ear pain
- Ear discharge
- Tinnitus(whether high pitched or low pitched, continuous or intermittent)
- Blocking sensation
- Itching sensation
- Vertigo
- Headache
- Nausea

Out of the total individuals:

- The subjects who complained of having reduced hearing sensitivity (RHS) were found to be 1019,
- The subjects who complained of having ear pain (EP) were found to be 329,
- The subjects complained of having ear discharge (ED) were found to be 245,
- The subjects who complained of having tinnitus were found to be 552. Out of them, 364 of the subjects complained of having high pitched tinnitus and 188 of the subjects complained of having low pitched tinnitus. Also 287 of the subjects had the presence of continuous tinnitus and 265 of the subjects had intermittent tinnitus.
- The subjects who had the presence of blocking sensation (BS) were found to be 293.
- The subjects who had complained of having itching sensation (IS) were found to be 216.
- The subjects who had the presence of vertigo were found to be 270.
- The subjects who complained of having headache were found to be 161.
- The subjects who complained of having nausea were found to be 62.

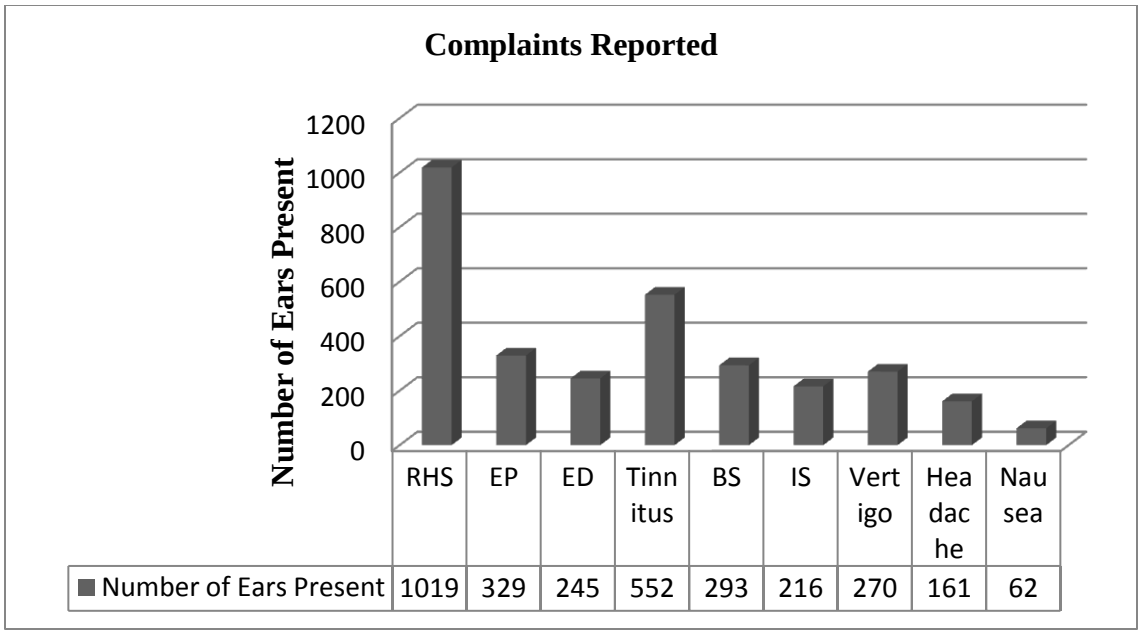


Figure 4:32. Distribution of various complaints reported by the subjects

4.8. Hearing Aids fitment

The individuals who were candidates for hearing aids were prescribed with them. Out of the total ears profiled, 828 of the ears were prescribed with Body Level (BL) hearing aids and 334 ears were prescribed with Behind the Ear (BTE) Hearing Aids. The remaining 944 ears were not given any amplification devices (Nil).

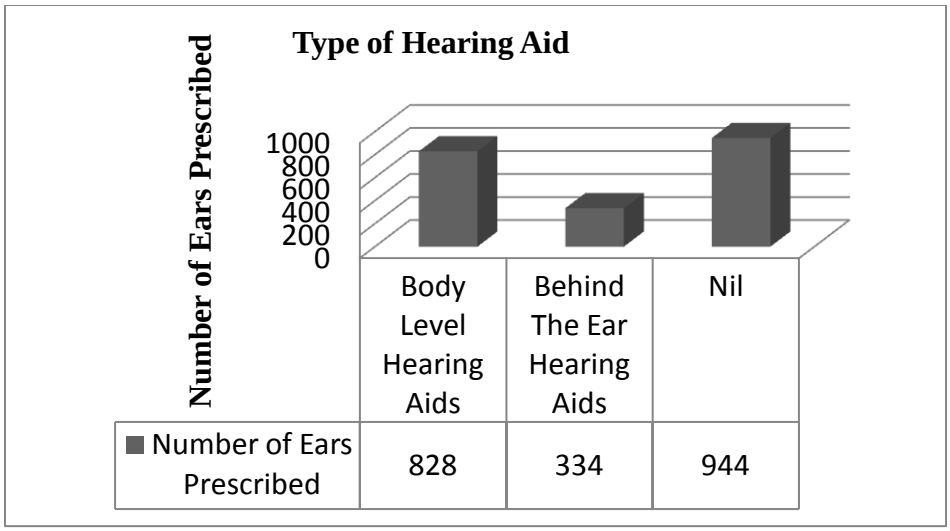


Figure 4:33. Distribution of the type of Hearing Aid prescribed

Out of the total individuals who procured Body Level hearing aids, 143 of their ears were fitted with Mild category hearing aids, 199 of their ears were fitted with Moderate category hearing aids, 340 of their ears were fitted with Strong category hearing aids and 146 of their ears were fitted with Extra Strong category hearing aids.

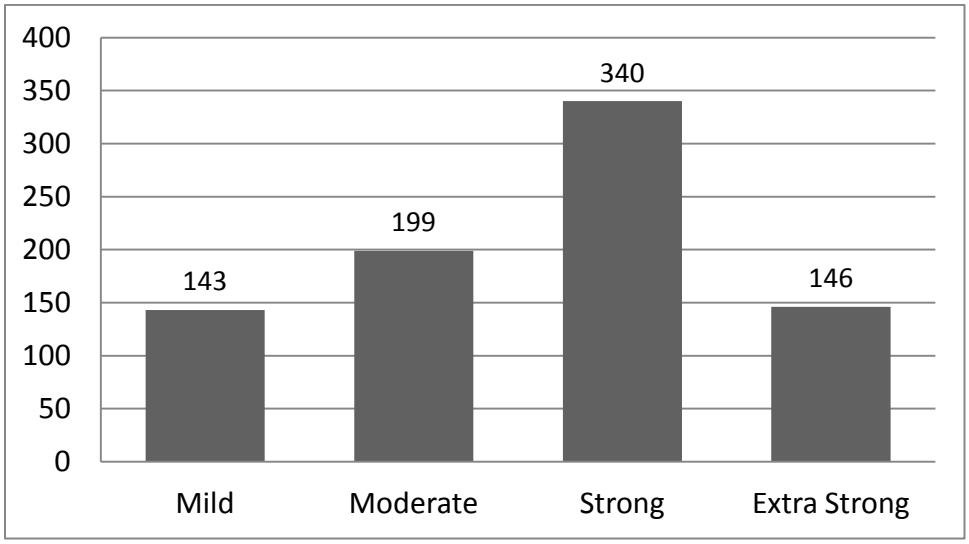


Figure 4:34. Distribution of the different category of Body Level Hearing Aids prescribed

Out of the total individuals who procured Behind the Ear hearing aids, 80 of their ears were fitted with Moderate category hearing aids and 254 of their ears were fitted with Strong gain hearing aids.

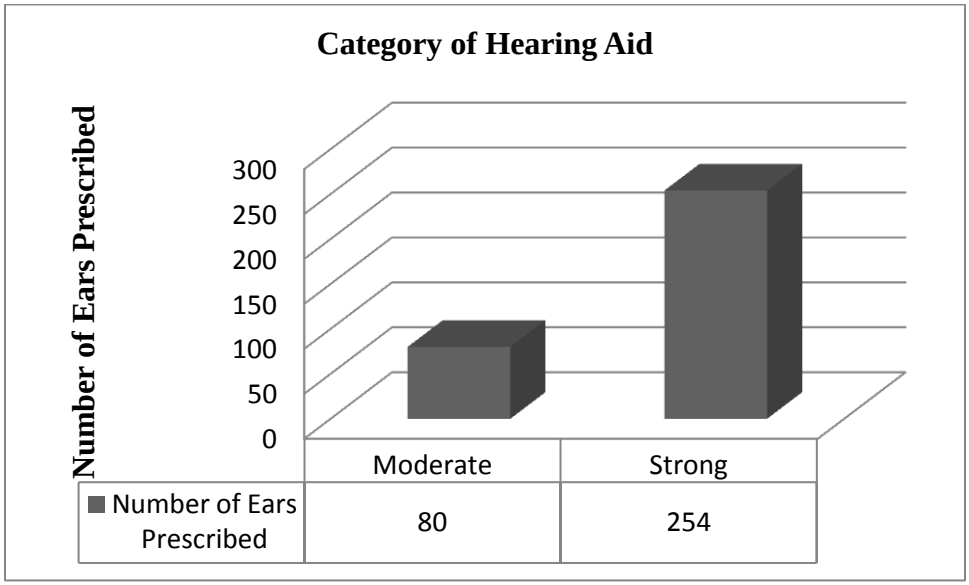


Figure 4:35. Different Categories of BTE hearing aid prescribed

To summarize the results, the pure-tone audiometry findings in the present study suggest that as the age increases the severity of hearing loss increases. Also, in the older population sensorineural hearing loss is the most prevalent type of hearing loss compared to conductive or mixed hearing loss. Tympanometric results shows almost the same results for male and female population.

Chapter 5

DISCUSSION

In the current study, a total number of 1053 case files were reviewed and analyzed for various factors like the different complaints reported by the patients, degree and type of hearing loss, configuration of slope of the audiogram, speech audiometry results, tympanometry and reflexometry results, Oto Acoustic Emissions results, Auditory Brainstem Responses results and the type and category of hearing aid prescribed to them. The results of these data confirmed that age related hearing loss is a major health issue in the ageing population of Mysore.

5.1 Degree of Hearing Loss

In the present study, as the age increased the degree of hearing loss was also found to be increased. Incidence of Mild hearing loss was more in 60-70 years of age whereas, for higher age group the milder degree of hearing loss was not present. Normal hearing sensitivity was present in only few ears in the age range of 60-70 years. For participants in the higher group the incidence of moderate to severe degree of hearing loss was more.

All the previous studies have reported that the aging auditory system typically exhibits a loss in the puretone threshold sensitivity (Moscicki et al. 1985). Majority of the studies confirm that hearing loss tend to decline with increasing age in both males and females (Moscicki et al. 1985). However, there is large individual variability in absolute hearing thresholds and in the amount of change with age (Gates et al. 1990). For example. Brant and Fozard (1990) reported audiometric profile in 813 individuals (age

range 20-92 years). Brant and Fozard (1990) reported that at 500 Hz and 8000 Hz for combined left and right ears there was an average hearing loss of 5.7 to 7.6 dB and 5.1 to 21.1 dB, respectively, for 20-year-olds, For 50 years old 10.0 to 12.7dB and 35.2-53.0 dB, and 22.9-48.5 and for 80 years old 69.0 to 84.5 dB for 80-year-old individuals. Cruickshanks et al. (1998) in a group of 3753 participants in the age range of 48-92 years old also reported that as the age increases the severity of hearing loss increases. Lee Matthews, Dubno and Mills (2005) also reported increase in degree of hearing loss with increase in age. The authors reported that the average rate of change in thresholds was 0.7 dB per year at 0.25 kHz, increasing gradually to 1.2 dB per year at 8 kHz.

The decline in pure-tone threshold occurs throughout the life with change at a greater rate after 50 years of age (Brant & Fozard, 1990). However, the prevalence of hearing loss increases with the age, with 41 % of adults over 60 years and older reporting hearing difficulties (Gates et al., 1990). Pure tone thresholds generally start to decline after an age of 50 years (Wiley, Chappell, Carmichael, Nondahl & Cruickshanks, 2008). However, it has also been reported that the initial signs of age-related hearing impairments are detected in females and males of 30-39 and 40-49 years of age, respectively and hearing loss is more in high frequencies (Sharashenidze, Schacht & Kevanishvili, 2007). In the next age decades of, 50-59, 60-69, and 70-79 years, the hearing losses increases in magnitudes and extended to lower frequencies (Sharashenidze et al. 2007).

The decline in pure tone thresholds can also be correlated with the anatomical and functional changes occurring in auditory system. The organ of corti is the structure most susceptible to age related histopathologic changes (Schuknect, 1993). Both types of hair

cells undergoes degenerative changes in the basal turn of the cochlea with apical and mid cochlear involvement of the outer hair cells as well (Willot, 1991). The decrease in the hair cells population is greatest in persons over 70 years of age and is most pronounced for outer hair cells. The population of outer hair cells reduces to 78% in the age between 50-60 years. Loss of inner hair cells and outer hair cells have been reported after 45 years of age (Engstorm et al. 1987), whereas for the subjects aged more than 60 years the degeneration was widespread along all the cochlear turns (Scholtz et al. 2001). Aging also results in the decrease in the number of spiral ganglion cells. Otte et al (1978) demonstrated that the total number of spiral ganglion cells in the cochlea's of young adults between 30,000 and 40,000 declining to less than 20,000 for persons between 81-90 years. There is a progressive loss of about 2,000 neurons per decade. All these changes might be leading to a pure tone threshold change in the older population.

5.2 Type of Hearing Loss

In all the age groups, the type of hearing loss which occurred the most is Sensorineural Hearing Loss followed by Mixed Hearing Loss which was followed by Conductive Hearing Loss.

This is similar to the results obtained by Liu et al. (2007); Hilton et al. (2008) and Sogebi (2015). This is because there is significant age related degeneration to the basilar membrane, organ of corti, stria vascularis, ganglion cells and other inner ear structures. Also ageing results in alteration of cochlear fluids (Hilton et al. 2008). Aging can lead to a structural or a functional deficit at various levels of the central auditory system

(Walton, Frisina, Ison & O'Neill, 1997; Hinjosa & Nelson, 2011; Nelson & Hinjosa, 2011; Suta, Rybalko, Jelanova, Popelar, & Syka 2011).

The prevalence of sensorineural type of hearing loss in the present study indicates that the changes in the auditory system occurs more in the inner ear compared to the outer and the middle ear. The second most prevalent type of hearing loss was mixed hearing loss which suggest that not only the inner ear but also the middle ear undergoes several changes. In the middle ear the changes which occur primarily in the outer ear associated with aging are; stiffening, thinning and loss of vascularity of the tympanic membrane (Covell,1952;Rosenwasser,1964), arthritic changes in the incudomalleal and incudostapedial joints (Etholm & Bellal, 1974), atrophy and degeneration of the fibers of the middle ear muscles and the ossicular ligaments (Covell,1952), ossification of the ossicles (Covell, 1952), calcification of the cartilaginous support of the eustachian tube and muscle function that opens the tube (Bellal, 1975). These changes in the middle ear along with changes in the inner ear would have resulted in mixed hearing loss.

For the individuals, who had only conductive hearing loss may not have the condition because of the aging factor rather than any other kind of middle ear dysfunction/pathology occurring such as otitis media or eustachian tube dysfunction etc.

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5.3 Configuration of Slope of Audiogram

For both males and females subjects the number of flat audiograms were more compared to the sloping and rising pattern of audiogram. Most of the subjects had flat

type of audiogram followed by sloping type and reverse slope was least type of audiogram.

Several studies have reported a more decline of auditory thresholds in higher frequencies compared to the lower frequencies. Brant and Fozard (1990) reported that at 500 Hz and 8000 Hz for combined left and right ears there was an average hearing loss of 5.7 to 7.6 dB and 5.1 to 21.1 dB, respectively, for 20-year-olds, For 50 years old 10.0 to 12.7dB and 35.2-53.0 dB, and 22.9-48.5 and for 80 years old 69.0 to 84.5 dB for 80-year-old individuals.Lee et al (2005) reported that The average rate of change in pure-tone thresholds for all subjects was approximately 0.7 dB per year at 0.25 kHz, with a gradual increase to 1.2 dB per year at 8 kHz and 1.23 dB per year at 12 kHz. Demeester et al. (2009) also reported that 'Flat' audiograms were most dominantly represented (37%) followed by 'High frequency gently sloping' audiograms (35%) and 'High frequency Steeply sloping' audiograms (27%). 'Low frequency Ascending' audiograms, 'Mid frequency U-shape' audiograms and 'Mid frequency Reverse U-shape' audiograms were very rare (together less than 1%).

The results can be correlated to the anatomical changes occurring in the older individuals. Loss of both inner and outer hair cells has been reported after the age of 45 years (Engstorm et al. 1987), whereas for the subjects above the age of 60 years, degeneration was widespread along all the cochlear turns (Scholtz et al. 2001). Felder & Fischer (1995) suggested that there was degeneration in the myelinated auditory nerve fibers in individuals aged lesser than 60 years and this degeneration occurred mainly in the apical nerve fibers. However, after 60 years of age the loss of myelinated fibers becomes uniform throughout the apical and basal region (Felder & Fischer, 1995).

Hence, these changes reflect that the prevalence of flat type of audiograms may be more compared to the sloping type of audiograms.

5.4. Tympanometry and Reflexometry

The type of tympanogram which is present the most is A type followed by As, B, Ad and C type.

There was no significant age and gender effects found for mean Tympanometric Peak Pressure (TPP) value which is consistent with the study reported by Chermak and Moore (1981); Wiley et al. (1996); Uchida et al. (2000); Stenklev et al. (2004) and Golding et al. (2007). The Eustachian tube plays a major role in the maintenance of TPP. The TPP remained unchanged in the elderly subjects because the age related changes in the middle ear are not much enough to change the ventilation to the middle ear through eustachian tube. Also there was no significant age effects for both mean Static Admittance (SA) and Ear Canal Volume (ECV) values which are in par with the findings of Nerbonne et al. (1978); Osterhammel and Osterhammel (1979); Uchida et al. (2000) and Nondahl et al. (2013). This is due to the fact that ageing produced only a slight stiffening of the middle ear structures. These findings are somewhat variable with the studies reported by Golding et al. (2007) and Wiley et al. (1996).

Both ipsilateral and contralateral reflexes were absent for majority of the individuals. This finding is in par with many studies (Golding et al. 2007 and Sogebi, 2014). This is due to the presence of hearing loss and some middle ear pathologies in majority of the individuals.

5.5. Oto Acoustic Emissions (OAE's):

OAE's were found to be absent in majority of the ears in older participant.

This absence of OAE in older could be due to the intrinsic aging of the auditory system particularly the OHC loss. The inner ear associated with aging can be affected in many ways. The organ of corti is the structure most susceptible to age related histopathologic changes (Schuknect, 1993). Both types of hair cells undergoes degenerative changes in the basal turn of the cochlea with apical and mid cochlear involvement of the outer hair cells as well (Willot, 1991). The decrease in the hair cells population is greatest in persons over 70 years of age and is most pronounced for outer hair cells. That is, hair cell population is less in older adults, especially for outer hair cells. However, there is significant reduction in the outer hair cell population in the mid age itself. The population of outer hair cells reduces to 78% in the age between 50-60 years. Also, most of these individuals had sensorineural hearing loss which suggests damage to the outer hair cells. Hence the OAEs are absent in most of the older individuals.

5.6. Auditory Brainstem responses (ABR)

ABR was found to be present in majority of the individuals which is contradictory with the results reported by Martini et al. (1991); Otto et al. (1982) and Ottaviani et al. (1991). This might be due to the fact that a lesser number of the individuals were assessed with ABR. And among them the number of subjects with the presence of hearing loss might be lesser. But majority of the studies reported affected ABR components with an increase in the degree of hearing loss as in Walter et al. (1982);

Ottaviani et al. (1991); and Martini et al. (1991). Majority of the cases on whom the ABR was performed were the subjects for whom the threshold estimation was done. The threshold estimation through ABR was done to inconsistent response to pure tone given by these individuals. Although, the audiometric results shows a severe degree or profound degree of hearing loss in these participants, the ABR suggest a lesser severity of hearing loss in these participants.

5.7. The Complaints Reported by the Patients

The majority of the individuals reported with the complaint of reduced hearing sensitivity followed by tinnitus, ear pain, blocking sensation, vertigo, ear discharge, itching sensation, headache and nausea. This is in accordance with the study reported by Sogebi et al. (2013) even though there are slight variations. Sogebi et al. (2013) also reported the similar complaints made by the older population in their study.

Chapter 6

SUMMARY AND CONCLUSION

The present study was conducted with an aim of documenting the various audiological findings in older individuals who visited the Department of Audiology at All India Institute of Speech and Hearing between July 2013 and April 2014. The data could be collected for 1053 clients in the age range of 60 to 98 years. Out of the 1053 participants, 711 participants were male subjects and 342 participants were female subjects. The various audiological test results which were documented for these clients are Puretone Audiometry results, Immittance test results, oto-Acoustic emissions, auditory brainstem responses and Hearing Aid fitment.

Following results were obtained in the present study:

1. The data analysis showed that there is an increment in the degree of hearing loss with the increase in age of the participants.
2. For most of the participants the degree of hearing loss varied from mild degree of hearing loss to severe degree of hearing loss.
3. The right ear had higher degree of hearing loss in all the elderly individuals.
4. Sensorineural hearing loss was predominant type of hearing loss in the older participants followed by mixed hearing loss. Conductive hearing loss was present in lesser number of participants.
5. The degree of hearing loss was more at higher frequencies compared to lower frequencies in both males and females as age increases.

6. The audiogram configuration which is predominantly present in elderly individuals is flat configuration followed by sloping and rising configuration.
7. In elderly males, the sloping audiogram configuration predominated followed by flat and rising configuration.
8. In elderly females, the flat audiogram configuration predominated followed by sloping and rising configuration.
9. Across all the elderly subjects, the type of tympanogram which is found the most is A type followed by As, B, Ad and C type.
10. There were no significant changes found in the parameters such as Peak Compensated Tympanometric Peak Pressure, Static Admittance and Ear Canal Volume as people age.
11. In majority of the elderly individuals, both ipsilateral and contralateral reflexes are absent and this increases with the presence of hearing loss.
12. Oto Acoustic Emissions were found to be absent in majority of the elderly individuals and especially if there was a presence of hearing loss.
13. The Auditory Brainstem Responses were found to be absent as the degree of hearing loss increased.
14. The majority of the elderly individuals reported with the complaint of reduced hearing sensitivity followed by tinnitus, ear pain, blocking sensation, vertigo, ear discharge, itching sensation, headache and nausea.
15. The majority of elderly individuals are found to be satisfied with Body Level hearing aids itself and a lesser number of individuals required the use of Behind the Ear hearing aids.

Thus the present study reported various degree and type of hearing loss in older participants. The present study is in agreement with previous studies reporting hearing loss in older participants. Most of these studies have reported the various audiological findings in the older participants in western population. Present study gives a good insight in to various audiological findings obtained in the older participants in the Indian population. Also, the present study gives an insight in to the different changes associated with aging in Indian population.

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