AUDIOLOGICAL FINDINGS IN GERIATRIC
A COMPARATIVE STUDY

Reg . No. - M. 8813

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A Dissertation Sumbitted in Part Fulfilment for the Degree of Master of Science. [Speech & Hearing)

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ALL INDIA INSTITUTE OF SPEECH AND HEARING

MYSORE - 570 006.

TO MY PARENTS

C E R T I F I C A T E

This is to certify that the Dissertation entitled "AUDIOLOGICAL FINDINGS IN GERIATRIC - A COMPARATIVE STUDY " is the bonafide work done in part fulfilment for Final Year M.Sc. (Speech and Hearing) of the student with Register Number M-8813.

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C E R T I F I C A T E

This is to certify that the Dissertation entitled "AUDIOLOGICAL FINDINGS IN GERIATRIC - A COMPARATIVE STUDY" has been prepared under my supervision and guidance.

Dr.(Miss) S. NIKAM
G U I D E

"*"

DECLARATION

This Dissertation is the result of my own study undertaken under the guidance of Dr. (Miss) Shailaja Nikam, Professor and Head of the Department of Audiology, Incharge Director of All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier at any University for any other diploma or Degree.

Mysore

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-: CONTENTS :-

-: ABBREVIATIONS :-

ABB	Auditory Brain-Stem Response
ART	Acoustic Reflex threshold
BSER	Brainstem evoked response
dB	Decibal
HL	Hearing level
KHz	Kilohertz
ms	Millisecond
MLR	Middle latency response
/uV	Microvolt
Rt	Right
Lt	Left
SD	Standard Deviation
SL	Sensation level
SPL	Sound Pressure Level
Yrs	Years
AC	Air-conduction
BC	Bone-conduction

INTRODUCTION

The branch of medicine that concerns itself with the prevention and diagnosis of problems associated with aging is called "Geriatrics", the term coined in 1909 by an American Physician, Ignaz, Leo Vaschers.

Accounts of the biophysical and behavioral changes that accompany the process of growing old have been well established since long time.

Hippocrates in 4th century B.C. described the reduced muscular tomicity, skin elasticity and blood circulation of the elderly. The traditional philosophies on aging held that growing old was an immutable transformation based solely on biologic changes. Current proponents of biologic aging can be divided into two camps: one who say that bodily cells are programmed to deteriorate at a certain chronologic age and those who profess that aging is a passive process in which cells simply wear out. (Hayflick, 1974).

The geriatric population, which is one of the major part of the society has been found to be contributing significantly to the betterment of society. They are a 'window' to the past, which aids in the maintenance of culture in the society. They also serve as a frame of reference to the youth, for meeting various problem in the different walk of life. The well being of the geriatric population is very important for the maintenant of integrity in the society.

The well being of the older people will be at state, due to several changes in social, psychological and biological processes that occurs concomitantly with age. One of the types of social trauma experienced as age advances is retirement from job. This affect the mental well being of the individual.

One of the most common problem is, a breakdown in the communication system in the older people. The impairment in communication is brought about mainly by changes in the sensory perceptual and speech mechanisms.

With increase in age, the hearing sensitivity deteriorates resulting characteristically in a high frequency loss. This condition was termed as"Presbycusis"by Zawaardemaker (1899). But presbycusis as understood now does not limit to only pure tone loss.

Phonemic regression, an expression coined by Gaeth in 1948, is a condition in which the ability to discriminate speech (measured with phonetically balanced monosyllabic words) is diminished in elderly individuals with presbycusis. The presence of an age related gradual decrease in the perception of speech, out of proportion to hearing loss for pure tones, has been confirmed in different studies (Pestatozza and Shore, 1955; Goetzinger and Rowsey, 1959; Klotz and Kelban, 1962).

Moller (1981) however found only a minor decrease in the discrimination score for monosyllabic words with age.

As presbycusis progresses, the decrease in hearing affects the ability to communicate. Age can affect several aspects of human hearing, which has been shown by changes in pure tone thresholds, speech audiometry, impedance audiometry and evoked responses. (Bergman, 1980, Jerger, 1984),

Marshall (1981) has reviewed the studies which show that the aging process affects hearing sensitivity.

The incidence of hearing loss in the elderly population is significantly high and the most common cause of hearing loss is presbycusis, or the loss of hearing due to aging process (Sataloff, 1966).

Presbycusis denotes a common but not universal deterioration of auditory function coincident with aging. Presbycusis manifest changes in the entire auditorysystem (Schuknecht, 1955)

Presbycusis deficit seen in many cases in gradually slopins gradually progressive, high frequency sensorineural hearing loss The loss increases gradually at first and then accelerates more rapidly with increasing age, especially for the higher freguenci (Berger, et al. 1977).

Approximately 35 percent of the American population over the age of 70 has a handicapping hearing loss. (National center for Vital and Health Statistics, 1967).

The aging person may have hearing loss from presbycusis, noise induced hearing loss (NIHL) and chronic middle ear disorder (Surjan, Devald and Palfel, 1973).

A systematic decline in static compliance with advancing age have been reported. Both men and women showed a decline in static compliance beyond age 30, which is attributed to change in middle ear tissues, muscles and ossicles. Also a systematic decline in acoustic reflex threshold with advancing age have been reported. The accuracy of predicting hearing sensitivity using acoustic reflex thresholds for pure tone and white noise is severely reduced in geriatrics (Jerger, et al. 1978, Hall, 1979).

The geriatric population as such manifest poor speech discrimination on conventional speech tasks. The reduction of speech discrimination ability has gained much attention. Herbert et al (1966) demonstrated reduced speech discrimination score for the W-22 word list for the individual over the age of 60 years. By increasing the difficulty of the speech task, the performance of the subject becomes very poor. The poorer performance of the geriatric population compared to the younger population on distorted speech, time altered speech, competing message.tasks have been reported by many studies (Bocca and Calearo, 1963; Beasley and Bess, 1977; Lutermann, welsh and Melrose, 1966; Carhart and Tillman, 1977).

The reduction in speech discrimination associated with the aging process, cannot be considered a purely peripheral auditory problem. The available data support that the speech discrimination difficulty in related to a generalized degenerative change in the auditory system including the central auditory nervous system (Bergmon, 1971; Beaseley and Bess, 1977

Jerger and Hayes (1977) have suggested that the central aging effect may be of good prognostic value in assessing the benefits of amplification and other aspect of aural rehabilitation.

Central auditory dysfunction might pass undetected in ordinary speech test because of the high intrnsic redundancy fof the speech material (Korson-Bengtsin, 1973).

Low redundant speech tests offer better prospects for the evaluation of central auditory disorders. In the elderly, the score obtained with such distorted speech tests are considerably lower than in young individuals (Calearo and Lazzaron 1957; Antonell; 1970; Jerger and Hayes, 1977).

Auditory brain stem responses (ABR) audiometry has been widely used to evaluate the function of the cochlear nerve and the auditory system at the brain stem level. Since ABR is dependent on synchronization over a large portion of the brainstem auditory pathway, it is regarded to be very sensitive to any disturbances in this anatomical region. (Borg, 1981).

The old individuals had generally longer ABR wave latencie than the young subjects. The I-V interpeak latency (IPL) was also prolonged in the older age groups compared with the group of younger individual, except for subjects with pronounced hearing loss. The result of ABR testing indicate that an age related dysfunction of the auditory pathway in the brainstem can be present in presbycusis.(Rosenhall, Pedersmn, Dotevali, 1986).

Need for the study:

A study of the present nature is important for several reasons*

First - 6% of the total population are over 60 years of age (1971 Census). Among the people above 50 years, 57.8% have been found to have hearing loss (Gill and Sharma, 1957). Thus mace than half the aged population are hearing impaired. But the medical and surgical services are of limited value to presbycusis. Therefore more effective audiological rehabilitation services are warranted.

The rehabilitation program centres around an accurate assessment of the handicap. In order to adequately assess the severity of hearing impairment, the factors of prime importance is reference standards against which a person' s hearing is evaluated. Therefore, while evaluating the sensitivity loss in an individual, the norms for the respective age group should be available. This is especially, so while assessing the hearing loss in the aged.

Due to the advance in the medical sciences, the life span of people all over the world is increasing. The Indian census in 1971, revealed a decrease in the death rate by nearly 5% during the past 70 years. The problem encountered by the aged has become the central interest in social and medical fields.

The present study was conducted to examine the audiological test results in geriatric population.

The study aimed at answering the following questions;

1. Is there increased loss of hearing sensitivity in geriatric population?
2. Is there increase in hearing loss is uniform in each frequencies (250 to 8000 Hz at octave interval)?
3. Is there increase in hearing loss differ from male to female
4. Is there any significant difference in static compliance value in geriatric population, compare to younger age?
5. Is there any significant difference for acoustic reflex threshold in geriatrics compae to younger age.
6. Is there any significant change in absolute latency of different peaks (I, III, VI of brain stem response ingeriatr compare to younger age?

7. Is there any significant change in inter peak latency (I-III; III-V; I-V) in geriatrics compare to younger age.
8. Is there any significant difference in amplitude (peak I and V) in geriatrics compare to younger age.

REVIEW OF LITERATURE

The effects of aging process on the human auditory system has been reported in the literature as early as 1800 A.D Zawaardemaker (1894), observed progressive deterioration of hearing for high frequency sounds with advancing age.

Jerger (1973) stated, the aging process produces systemati, changes in each of the two critical dimensions of hearing impairment - loss in threshold sensitivity and loss in the ability to understand suprathreshold speech.

Earlier the structural alterations in the presbycusis ears was believed to be limited to the peripheral portion of the auditory system. (Davis, 1970). But in recent years, many histopathological studies on presbycusis ears have disclosed that no portion of the auditory system is immune to senescent changes. The physiological alterations in presbycusis ears thus involves all the major divisions of peripheral and central auditory mechanism.

Marshall (1981) has reviewed the studies which showed that the aging process affects hearing sensitivity. The incidence of hearing loss in the elderly population is significantly high and the most common cause of hearing loss is presbycusis, or the loss of hearing due to the aging process (Sataloff, 1966).

Pure tone audiometry:

The pure tone test results generally reveal a bilateral sensory neural hearing loss sloping downward through the frequencies above 2 KHz in geriatrics. Miller and Ort (1965) reported this slop in 88% of a group of individuals over the age of 65 years. Average hearing loss ranged from 16 to 60 dB bilaterally. Generally, the loss of greater for men in frequencies above 4 KHz, whereas women show a greater loss toward the lower frequencies (Department of Health, Education and Welfare)U.S.A.). Miller and Ort attributed the differences in the high frequencies to greater noise exposure in men then in women.

Bunch (1929, 1931) reported a change in hearing sensitivity as reflected by the pure tone audiogram is the best known alternation in auditory function associated with the aging process. He reported a gradually progressive reduction in sensitivity beginning at about age 30. The hearing loss primarily affected frequencies above 1000 Hz. and was shown to progress systematically through beyond age 60 years.

Sataloff and Menduke (1957), observed little increase in hearing loss in men or women from age 65 years through age 90 years. The hearing loss tended to be bilaterally symmetrical as only 10 percent of the subjects had an ear difference of 10dB or more. Melrose, Walsh and Luterman (1963) reported in a group of 62 men between the age of 74 and 89 years. Subjects exhibited a gradually sloping, bilaterally symmetrical, sensorineural hearing loss with greater loss in the high frequencies, No correlation was found between age and degree of hearing loss.

Presbycusis manifest changes in the entire auditory system (Suhuknecht, 1955).

Presbycusis deficit seen in many cases is gradually sloping, gradually progressive, high frequency sensorineural hearing loss. The loss increases gradually at first and then accelerates more rapidly with increasing ages, especially for the higher frequencies. (Berger et al. 1977; Corso, 1963; Glorig and Nixon, 1962; Glorig and Roberts, 1965). But not all presbycusi hearing losses follow the typical audiometric configuration.

Dayal et al (1970) found a 31% incidence of flat audiometric configurations in the presbycusis sample.

Schuknecht (1975) has described is different types of presbycusis.

1) Sensory (2) Metabolic or strial (3) Mechanical or cochleqr (4) neural

Sensory presbycusis is characterized by an abrupt high-frequency loss. Metabolic presbycusis is characterized by a flat audiomet patterns.

Mechanical presbycusis is associated with a gradually sloping high frequency hearing loss. Neural presbycusis is implicated When speech discrimination ability is poorer, than would be expected from the audiogram.

The aging person may have hearing loss from presbycusis noise induced hearing loss (NIHL) and chronic middle ear disorder (Surjan and Devald and Palfal, I. 1973). Plom (1978) suggested that 24% of the population is handicapped at the age of 65 years. Over 30% by age 70 years and 50% by age 75 years.

Liden (1967) and Aniansson (1974) have demonstrated that persons with high frequency hearing losses are handicapped in noisy situations, even if their hearing for 500 Hz, 1000 Hz and 2000 Hz is essentially normal*

The peripheral sensitivity loss differs for men and women in terms of age of onset (Corso, 1963a; 1963 b) . Where reduction in hearing sensitivity developed in males between the age of 26 and 32 years and in females at about the age of 37 years. The onset was seen to be more gradual/in women, the rate of progression was greater in female, by age 51 to 57 years (Corso, 1963 a, 1963 b) . Where women exhibited poorer low frequency hearing than men. Men showed better hearing for the low frequencies whereas women exhibited better high frequency hearing.

Goetzinger and his associates (1961) - reported that women showed better hearing in the high frequencies whereas the men showed more sensitive hearing in the low frequencies.

Milne and Lauden (1935) - examined the pure tone sensitivi of nearly 500 person between 62 and 90 years of age. Women demonstrated a greater hearing loss at 1000 Hz and below, where ten exhibited a greater loss at 2000 Hz and above. The hearing loss related to aging is reported to be sensorineural in nature singular changes in the bone conduction responses have been reported and related to the aging process.(Carhart, 1958; Melro et al. 1963).

The Bernero phenomenon is a condition whereby cortical differentiation of two trains of neural impulses (B.C.) is more difficult than the differentiation of a single (A.C.) trail Carhart (1958) described the Bemero effect, which is manifested by a greater loss by bone conduction than air conduction at 500 Hz and this change in responsivity due to central perceptual disturbance. (Thisreduced bone conduction response at 500 Hz, is more likely a reflection of central auditory dysfunction).

Glorig and Davis (1961) - described a high frequency air-bone gap that they ascribed to an age related increase in stiffness of the cochlear partition. The air bone gap was press at 4000 Hz and increased from 10 dB at 50 years of age to 40 dB by 80 years of age. The age related air bone gap might be used in the identification of noise induced hearing loss and allow for meaningful correction of compensable hearing loss.

Milne (1977 b) - compared air and bone conduction threshol at 1000 Hz and 4000 Hz. At 1000 Hz, 16 percent of the men and 18 percent of women demonstrated an air-bone gap greater than 10 dB, where as at 4000 Hz, 58% of men and 34% of the women exhibited a similar air bone gap. There was no significant co-relation between age and the size of the air-bone gap. Milne (1977) related the high frequency air-bone gap to a loss in mechanical activity in the muscular joints causing a dissipation of primarily high frequency energy.

Pederson, Rosenhall and Moller (1989) reported that hearing loss was most pronounced at higher frequencies for both sexes, and men had an average of 10 dB greater hearing loss at 8 KHz than women. The decrease in hearing threshold in men between the ages of 70 and 81 years was more pronounced at 2 KHz (27 dB) than at 4 and 8 KHz (15 and 20 dB respectively The average hearing loss in women increased at a constant rate between the ages of 70 and 79 years (15 dB), while between the ages of 79 and 81 years the change in pure tones threshold was minimal.

Hinchcliffe (1959) found significant differences in the level of hearing in certain frequencies in younger age group of both the sexes, from his survey he found that in all the groups covering the age range 18-54 years the hearing levels of women were significantly lower than those of men at 3000 Hz, 4000 Hz and 6000 Hz. while in older age groups significant differences were also found at 2000 Hz and 8000 Hz so they concluded that bone conduction shift could be caused by inner ear conductive presbycusis that resulted from a stiffening of the basilar membrane due to aging.

Magladerg (1959) stated that atrophic changes in the elderly occured in the supporting walls of the external auditor meatus.

Goetzingon (1965) has mentioned that many patients were unable to respond to maximum audiometric stimulation at 8 KHz.

Farrior (1963) has shown that geriatric patients are also vulnerable to otosclerosis which is thought by many to be a disease of the younger person.

Glorig and Davis (1964) have also reported data Which suggest that some pathological condition exists in the conductive apparatus of the auditory mechanism of the aged patients. Poor major age effects have been identified in presbycusis. One is central presbycusis, another is the classifical sensory neural presbycusis; a third is middle ear conductive presbycusis and the fourth is inner ear presbycusis which show considerable high tone hearing loss by bone conduction. These age affect may occur in any combination.

Rosen Wasser (1964) enumerated structural changes in the aged ear as ossicular atrophy paticularly in the crura of the stapes, ossification of the incudo malleolar joint with calcification of the articular cartilage, degeneration and atrophy of the middle ear muscles, a thin and translucent, tympanic membrane and atrophy and thinning of the skin that lines the external meatus together with loss of elastic tissues elements.

Anderson (1967) reported that the problem of aging is the greatest hazard facing medical sciences since the conquest of the infections diseases.

Glorig (1967) termed presbycusis as those impairment resulting from physiologic changes that accompany, aging, and losses, stimming from the noise exposure of our social environment he calls sociocusis.

Burn (1968) freported that in presbycusis progressive deterioration of hearing of high tones occured. From audiological studies on young and old people he found that the higher the frequency of the test tones. The greater was the hearing threshold and older the person the greater was the deterioration.

Hinchcliffe (1968) found that in a British sample the average threshold for males was poorer than those for the females. This difference was attributed to the cochlear damage due to noise to which the men had been exposed.

Nomura and Kirikae (1968) studied the cochlea of 30 aged people histologically as well as histochemically to demonstrates the pathology of sensorineural elements in the organ of corti. Loss of sensory cells was found to be most severe near the basal end of the cochlea and. less towards the apex.

Hinchcliffe (1973) stated that impairment of hearing in advanced age, known by the name of primary ideopathic pres-bycusis, was a deafness of the perceptive type without recruitment and therefore the changes mere not primarily loca-lised in the organ of corti. It was characterized by a high tone loss of hearing, so that the changes might be localized in the basal coil of cochlea. The longest frequencies of 1000 Hz - 2000 Hz were impaired much earlier, frequencies of 4000 Hz to 8000 Hz disappeared as early as the age of 40 years.

Ichiro Kirikae, (1968) studied the effect of senile changes in the retrocochlear pathway on the auditory function in advanced age. The subject ranged from 60 to 75 years. In these subjects the pure tone thresholds at 250, 500 and 1 KHz stayed within 10 dB of normal hearing level. Their results indicated the presence of retrocochlear lesions in advanced ages showing senile changes are distributed along the auditory pathway from the level of spiral ganglion to the auditory cortex. Although there is no question that presbycusis is partly caused by lesion of the inner ear, senile changes of the nerve cells in the central auditory pathway must also play an important role as the cause of presbycusis.

Milne (1977b reported increase in hearing loss were small after one year but greater after 5 years especially at higher sound frequency in a longitudinal study of persons age 62-90 years. Some subjects showed increased loss at all frequencies measured. The regressions from frequencies of 1000 Hz, and 4000 Hz showed age effects i.e. increase loss over five years as age at entry increased only in men at 1000 Hz.

Muscicki, et al (1989) reported in epidermiologic study of the Framingham Heart Study Cohort. The subject were 935 men and 1358 women, age range 57 to 89 years. Using a definition of hearing loss as threshold levels greater than 20 dB above audiometric zero for at least one frequency from 0.5 to 4 KHz, the prevalence was estimated to be 83%. The majority of cases displayed a sensorineural hearing loss. There were no statistically significant difference by sex at 1 KHz and below, woemen had significantly better hearing than men at 2KHz and above.

Ronald et al (1980) studied the specific frequency and degree of hearing loss in 202 elderly nursing home resident (159 females, 43 males) and reported pure tone averages (500, 1000, 2000 Hz) for the better ear showed a substantial deterioration in each decade interval beginning from ages in the 60s and extending into the 90s. Mean threshold for the various age categories reveal a gradual decline in hearing with age at all frequencies and for the better ear pure tone average. The mean within each group are generally similar at 500 Hz and 1000 Hz but show a drop of 5-8 dB at 2000 Hz and a further drop of 13-17 dB at 4000 Hz.

Speech discrimination:

Next to the changes in hearing sensitivity, the deterioration in speech discrimination is the most common characterist of age related changes in auditory function.

Gaeth (1948) credicted, the reduction in speech discrimination that characterizes the auditory problems manifested by aging client. He coined the term phonemic regression to describ this clinical phenomenon.

Pestalozza and Shore (1955) studied speech discrimination in a group of subjects over 60 years of age. The reduction in speech discrimination could not be related to degree of hearing loss or slope of the audiometric configuration. No corelation was found between the speech discrimination score and presence or absence of recruitment. They suggested therefore that the reduced speech discrimination was related to degenerative chang involving spiral ganglion cells and fibers of the eight nerves.

Goetzinger (1961) using subjects ranging in age from 60 to 90 years, demonstrated a significant age and ear effedt for discrimination score obtained using the CID-W-22 word lists. The speech discrimination problems in aging were the result of a composite of changes in the auditory system andwere not related to degeneration at any single level.

Reduction in speech discrimination scores has been related to the degree of sensorineural hearing loss rather than age by some researchers. (Harbert and Mendulle 1966;Kasden, 1970).

Harbert et al (1966) showed reduced speech discrimination score for the W-22 word list for the individual over the age of 60 years having negatives otologic histories and pure sensord neural hearing losses. The reduced speech discrimination score; were more strongly related to degree of hearing loss than to subject age.

Kasden (1970) failed to demonstrate an age related reduction in speech discrimination.

Surr (1977) did not find any differences in speech discrimi nation scores across age group with mild high frequency hearing losses for NU-6 word list at 40 dB SL.

Rintelmann and Schumaier (1974) demonstrated a significant age related reduction in speech discrimination in subjects over 60 years of age matched in terms of degree of hearing loss with younger hearing impaired person.

<u>Speech discrimination in ideal listening conditions:</u>

Jerger (1973) have found decrease in PB max. with aging is similar to the decrease in absolute sensitivity with aging. Jerger also examinined mean, PB max. Score as a function of age for groups with varying degrees of hearing loss (grouped by pure tone average) and he observed slight decrease in PB max, with age when the presentation level was sufficiently intense to overcome the attenuating effect across all frequencies

Luterman, Walsh, Melrose (1966) have found more errors for elderly than for young listeners on W-22 word list at 40 dB SL.

An age effect on speech discrimination scores was demonstrated by Bess and Townsend (1977) they suggested an interaction between age and degree of hearing loss. Subjects with pure tone averages better than 40 dB did not demonstrate any apparent age related reduaction in speech discrimination. However, the age effect become apparent for individuals, exhibiting a sensorineural hearing loss in excess of 40 dB.

The reduction in speech discrimination associated with the aging process, cannot be considered a purely peripheral auditory problem. Available research studies support, the contention that the speech discrimination difficulty &s related to a generalize degenerative change in the auditory system including the central auditory nervous system. (Bergmon, 1971; Jerger, and Hayes, 1977 Konkle, Beaseley, and Bess, 1977; Orchik and Burgess, 1977).

Bergman (1971) reported a significant reduction in discrimination ability in the absence of any peripheral sensitivity loss, after examining the speech discrimination ability of normal hearing adults, between the age of 20 and 79 years using a various of altered speech tasks.

Konkle et al (1977) used a time compressed speech discrimination task and they reported differential effects for age and time compression. Specifically, time compressed speech discrimination scores showed/a consistent decline with increasing age. The greater the amount of time compression, the greater was the demonstrated age effect.

Orchik and Burgess (1977) examined synthetic sentence identification (SSI-ICM) as a function of age of the listener. Four age groups were examined and all subjects had normal peripheralhearing sensitivity. The two oldest age groups (t o 49 years and 60 years and above) showed a significant reduction in discrimination when the synthetic sentences were presented against a competing message of continuous discourse mixed in the same ear (SSI-ICM).

Speech discrimination for altered speech:-

Elderly people generally experience difficulty with all types of altered (i.e. frequency related altered, or temporally related altered) speech (schow, et al, 1978), but there are many inconsistencies across studies.

The elderly have demonstrated decreased performance on fast speech (Bergomon, Blumenfeld, Caseardo, Desh, Levitt, and Margulles, 1976) interrupted speech (Bergmon, 1975; Bergman et al 1976; Kirtkar et al. 1964) and reverted speech (Bergman, 1971, Bergman, et al 1976).

Korobic, et al reported found poorer performance for elderly listeners in comparision with young listeners, where the elderly listeners had high frequency sensorineural hearing losses and poorer speech discrimination scores for unaltered speech and the test words were presented at relatively low SLS.

In young people with normal hearing, the performance/ intensity function (PI) for phonetically balanced monosyllables (PI-PB) and for synthetic sentence identification in the presence of competing noise (PI-SSI) were similar, but in order people statistical differences are found due to their relatively poor performance on the synthetic sentence identification (SSI) task. (Jerger and Hynes, 1977).

Persons with normal hearing or slight hearing loss in the older age group revealed that scores on the synthetic sentence identification task (SSI, s/N=OdB) have a tendency to be worse in comparislon with the discrimination scores for phonetically, balanced words in silence. (Debruyne, T. Berghein, Y. 1989)$

Rellover implies a significant reduction in speech discriminationability at high intensity levels and is consistent with eighthnerve dysfunction. (Jerger, (1971) suggested that significant rollover is rarely found in cases other than eighth nerve legions, except in the elderly patient. Only 9 of the 741 cases (other than 8 nerves cases) demonstrated significant rollover in the subject over 50 years of age.

Gang (1976) found a strong relationship (r=0.83) between the age of the listener and the amount of rollover suggesting that the likelihood of eighth nerve involvement increases with age.

Impedance audiometry;

Impedance audiometry has become a standard part of the audiologic battery. Its clinical utility included applications in identification auditory as well as differential diagnosis.

The Impedance battery includes three measures: Tympanometry, static compliance; and acoustic reflex assessment.

Tympanometry represents an assessment of the changes in efficiency of the middle ear system as air pressure is varied in the external auditory meatus (Jerger, 1975). The results of tympanometry are plotted graphically and referred to as a tympanogram and it is very useful in assessing middle ear function.

The changes that have been reported appear to interact which changes in the types of middle ear disorder that affect various group. In children, a relatively high percentage of tympanogram associated with otitis media are observe An increased incidence of tympanogram types associated with ossicular abnormalities (i.e. Stapesfixation) is observed with advancing age. (Jerger, 1970).

Blood and Greenberg (1976) reported that "A significant increase in impedance was noted in aged 50 years and older".

Static compliance involves the measurement of the compliance of the middle ear in its resting or static state by determining the volumeof air that has a compliance equivalent to that of the middle ear system (Jerger, 1975). Middle ear system become increasingly compliant upto middle age and then stiffen with further aging. (Alberti and Kristensen,1972).

A systematic decline in static compliance with advancing age has been demonstrated (Jerger, Jerger, and Mouldin, 1972). Woman showed consistently lower static compliance at each level.

Hall (1979) found the six difference in static compliance to be most pronounced between 30 and 60 years of age. Both men and women showed a systematic decline in static compliance beyond age 30, which he attributed to changes in middle ear tissue, muscles and ossicles.

The acoustic reflex threshold is the lowest sound intensity that will elicit a detectable contraction of the stapedius muscle (Jerger, et al 1972). In the normal hearing population, approximately 95% of the acoustic relex threshold fall between 70 and 100 dB hearing level (HL) with a mean of approximately 85 dB HL (ANSI-1965).

A systematic decline in acoustic reflex threshold with advancing age have been reported. No sex differences has been observed in acoustic reflex threshold in geriatrics (Jepsin, 1963; Jerger, et al. 1972).

Seavertom and McLennon (1976) found that the acoustic reflexes in their three age group were elicited at equivalent sensation level; the supraacoustic reflex amplitude were reduced in the oldest groups of 60 to 70 years as compared to 20-30 and 40-50 years.

Jerger, Hayes, and Anthony (1978) demonstrated that the accuracy of predicting hearing sensitivity using acoustic reflex thresholds for pure tones and white noise is severely reduced in elderly patients. Jerger, et al (1978) found a decline in acoustic reflex threshold for puretone stimuli, but for broad-band noise, the age effect was nonexistent.

Silman (1979a) found no difference in acoustic reflex thresholds for pure tones between young and elderly normal hearing adults, but found increased acoustic thresholds for white noise in the elderly subjects.

Thompson, Sils, Recke, and Bui (1980) found no change in acoustic reflex thresholds for either pure tones or filtered white noise as a function of age for normal hearing adults, but did find decreased growth of the acoustic reflex to these stimuli with increasing age.

"Thompson, et al (l980) reported growth in amplitude of the acoustic reflex to filtered noise and tones of 500, 1000, and 2000 Hz. in 30 persons between the age of 20 and 79 years. Although thresholds of the acoustic reflex did not vary significantly across the age range of the subject sample, the rate of growth in Amplitude decrease linegrly with increase in age decade.

Jerger, et al (1978) reported a gradual reduction in acoustic reflex thresholds (ART) to tones of 250 Hz, 500 Hz, 1 KHz and 2 KHz in subjects between the ages of 20 and 59 years.

Margolis, et al (1978) reported a decrease in acoustic reflex thresholds to wide-band noise, in subjects over the 20 to 67 years age range.

Wilson (1981) reported as the immittance changes between the quiescent and reflexive states as a function of both the activator sound pressure level above the reflex threshold. There have no significant differences between the static immittance values for the two groups (below 30 years and above 50 years). Although acoustic reflex thresholds for the two groups were the same in the low and mid frequencyregion (250-2000 Hz), the reflex thresholds for the above 50 years group were elevated significantly (8 dB) for 4000 Hz, 6000 Hz, and noise activators. In all the condition, the magnitude of the acoustic reflex was substantially smaller for the above 50 years group as compared with the below 30 years group.

Hall (1982) reported subject age and sex markedly influence reflex amplitude over the range of 20-80 years, maximum reflex amplitude, on the average,decreased by 56%. Both uncrossed and crossed reflexes were affected, the age related amplitude changes were usually more pronounced for uncrossed reflexes.

Amplitude for crossed reflexes is diminished in comparision to uncrossed amplitude in all the subject. There is a marked sex difference in both uncrossed and crossed acoustic reflex amplitude. Over most of the intensity range, the amplitude differences regularly increase with signed intensity. At the highest intensity level, neither males nor female in older group show further amplitude growth. However amplitude growth was greater in females. The sex differences in the older group is statistically significant for the 1000 Hz signal, as well as 4000 Hz and the 500-1500 noise band.

Wilson (1981) reported no significant difference between the static immitance value for the two groups of subject (below 30 years and above 50 years) although the below 30 years group had slightly higher static admittance (lower static impedance) than the above 50 years group, thus difference were nonsignificant. The acoustic reflex threshold for the two groups were the same in the low to mid frequency region (250Hz - 2000 Hz) the reflex threshold for the above 50 years broup were elevated significantly (8 dB) for 4000 Hz and 6000 Hz. In all the condition, the magnitude of the acoustic reflex was substantial] smaller for the above 50 years group as compared with the below 30 year group. The variability of the reflex magnitude was larg for the both group of subjects. Saturation of the individual growth function, which was frequency dependent, occurred twice as often with the above 50 years group as with the below 30 year of group.

Special Auditory Test:

Pestalozza and Shore (1955) suggest the most important indication is that theusual relationship between auditory tests do not hold true for presbycusis. The presbycusis population exhibit wider variability on most measures designed to identify a site of lesion in the peripheral auditory mechanism. This variability reflects the generalized deterioration that characterized the aging of the auditory system.

a) Short-increment sensitivity index: (SISI):

Jerger, et al (1959) described presbycusis as a clinical entity in which the SISI score was quite unpredictable. In a group of 34 elderly subjects SISI scores at 1000 Hz and 4000 Hz ranged from 0 percent (in retrocochlear involvement) to 100 percent (in cochlear disorder).

Young and Herbert (1967) did not found any difference between presbycusis and various cochlear disorders for SISI scores across a range of sound pressure levels or at high levels.

Koch et al (1969) and Cooper (1976) found that the high intensity SISI task at either 75 or 90 dB HTL serves as an excellent screener task for eighth nerve peripheral neutral transmission deficits. They report on confirmed eighth nerve locus tumors where low scoring negative SISI values were report, on the ear with the transmission problem.

Jerger (1973) reported on a patient with left temporal lobe damage who had suppressed SISI scores for the right ear for sensation levels raising from 60 to 95 dB. He stated that "startling deficits in intensity descrimination appeared in the ear opposite the affected side of the brain.

Punnan (1976) studies of SISI on/presbycusis shows unpredictability of SISI scores. This may be because of low level of presentation (tone presented at 70 dB HL) The result showed that no pathology is detectable in the cochlea and the presbycu ear behave like normal ears.

b) Loudness balancing:

Recruitment as an abnormal growth in the loudness function is a clinical manifestiona generally associated with cochlear pathology involving the hair celle. The presence of recruitment is indicative of cochlear pathology whereas the absence of recruitment is more consistent with neural involvement (Feldman, 1976).

Pestelozza and Shore (1955) studied performance of 24 subjects over the age of 60 years who had densorineural hearing losses, using the alternate binaural and monaural loudness balance teat. The results indicated considerable variability in performance on the part of the presbycusis subjects with no apparent correlation between the presence of recruitment and the speech discrimination score.

Goetzinger et al (l961) studied the performance of 90 subjects between the ages of 60 and 90 years using a variety of auditory tests including the alternate binaural and monoaura loudness tests. The result showed that only 35 percent men and 17 percent women demonstrated complete recruitment.

Harbert et al (1966) used two monaural loudness balance tests to assess the incidence of recruitment is 50 subjects over the age of 60 years. Recruitment was found in less than 30 percent of the subjects. The absence of recruitment was often associated with an elevated mural overload threshold, suggesting that the cochlear dysfunction inaging may be a mechanical disturbance such as increased stiffness of the basilar membrane.

The recruitment is not always manifested in sensorineural hearing loss associated with aging. The absence of recruitment may be one indication of a change in cochlear mechanics and is consistent with the changes in the cochlear stiffness gradua reported by Schuknecht (1964).

c) Auditory adaptation:

Auditory adaptation is measured in two ways clinically, through tone decay testing and Bekesy audiometry. The presence of exccessive auditory adaptation is regarded as a sign of acou nerve involvement. Tone decay test may involve threshold or suprathreshold stimulus (Olsen and Noffsinger, 1974; Jerger and Jerger, 1975). The amount of adaptation usually seen on clinical tone decay test i.e.30 dB or less (Gang, 1976; Olsei Noffsinger, 1974).

Goetzinger et al (1961) used a threshold tone decay procedure in evaluating the subjects between 60 and 90 years. No significant tone decay was found at any age level. Few subjects demonstrated presence of tone decay at 2000 Hz.

Punnan (1976) also failed to obtaine any significant decay in presbycusis. Using a suprathreshold task, Jerger and Jerger (l975) demonstrated a significant tone decay at 4000 Hz in patients with presumed cochlear hearing loss.

Willeford (1971) reported abnormal tone decay for only a small number of elderly subjects. Presbycusis subjects usually did not show the abnormal fatigability that is expected with a retrocochlear site of lesion; but it is important to measure rate as well as amplitude of adaptation(Wlly and Lilly, 1980).

Jerger (1960) using Bekesy audiometry did not find significant auditory adaptation in presbycusis. Bekesy tracings are usuallyType I or II (normal or cochlear site of lesion, for presbycusis subjects (Harbert et al 1966 and Jerger, 1960) and show not abnormal fatigue.

Auditory Brain Stem Response:

The auditory brain stem response (ABR) audiometry is of great importance today in the field of audiology, otology, and neurology. It is an objective way of assessing hearing in all types of cases. ABR has been widely used to evaluate the function of the cochlear nerve and the auditory system in the brain stem including difficult to teat subjects; since it is not affected by sleep and sedation.

Jewett and Williston (1971) has identified a series of given small waves during the first 10 ms which could be recorded from the earlobe, ver/tex electrodes in response to a series of small stimuli, either wide band clicks or high frequency tone bursts. A review of the result of auditory brain stem response on age and sex seems clear that there was significant age and sex effects on the ABR peak latencies and interpeaks intervals (IPI). The results havebeen controversial about the role of age on auditory brain stem responses.

There was appreciable prolongation of latency with increas ing age* The amplitude was also diminished with age until in the 8th decade. This may be due to lack of syncrhony between individual/responses following individual stimuli. The mean latency of wave V from trial to trial and subject to subject di not show very great changes, so it is necessary to postulate a greater scatter of individual response latency and thus poor synchrony, with increasing age. Secondly, the increased tissue impedance may have played a part in the diminition of amplitude noted in the older subjects. (Beagley and Sheldrake, 1978).

High frequency hearing loss has been demonstrated to significantly delay (i.e. 2 to 5 ms) onset of the auditory brain stem responses even When hearing is normal within the primary speech frequencies i.e. 500 - 2000 Hz (Coats and Martin, 1977).

Rowe (1978) reported significant latency differences between the elderly and the young subjects; however his procedure for selecting the subjects did not rule out the possibility of participation of subjects with high frequency hearing loss. Rowe (1978) studied his subjects into two age groups of mean age 25.1 year and 61.7 years respectively finds (in response to clicks at 60 dB HL at a rate of 80/sec),a difference between means of 0.2 msec, for wave I, 0.44 m.sec. for wave III and 0.36 m.sec. for wave V, old subject showing longer latencies than young. The interpeak interval differences between old and young subjects are smaller than his peak latency difference Older subjects exhibited longer peak latencies than the younger. He also reported shortening of the I-III, III-V, and I-V interva when the click intensity is reduced from 60 to 30 dB HL (Click rate 30/sec)- in both older and younger subjects.

Beagley and sheldrake (1978) found significant difference regard to sex, and only a minimal increase in latency of wave V as a function of age and did not find any significant difference inlatency for any wave and observed longer latencies of Waves III and V in males. McCandles (1982) reported only slight age dependence of ABR latencies. Hall (1960) reported a shorter wave V latency in females than in males.

Rosenhamer et al (1980) found no significant latency difference between males and females among the old subjects. Shorter peak latencies in females (below 50 years) than men and sex difference was not significant above the age of 50years

Thomson et al. 1978, Jerger and Hall, 1980 have found for peek V and Johnson (1984) for III, IV, V and VII significant latency differences between young and older persons.

Maurizi et al (1982) found a significant copulation between age and interpeak latency (IPL) I-V in males.

The percentage difference between the younger and the older subjects showed/a decreasing wave occurrence with increasing age. There was an absence of II, III, V wave complexes with increasing age at low intensity levels (30 dB HL). There was growing wave latency with age. The amplitude value show no significant age dependency (Von Wedel, 1979). He concluded that a reduction in the number of excited nerve fibers and reduced transport processes, in all regions in the pathways upto the nucleus of the lateral with growing age.

Debruyne (1986) demonstrated the latency shift of wave V of the auditory brainstem response (ABR) caused by increasing the stimulation rate. An increased click rate causes a prolong. ation of wave V latency, and the effect seems to be greater in the older age groups. He reported that the wave V of the auditory brain stem responses showed a greater latency prolongation when the stimulus rate was increased. He found no statistical correlation between the scores on the synthetic sentence identification task and prolonged latency of wave V of the auditory brainstem responses in older age group. So, they seem to be the result of two independent processes.(Debruyne, 1989).

Rosenhall et al (1986) reported that the oldindividuals had generally longer ABR wave latencies than the young subjects. The I-V interpeak latency (IPL) was also prolonged in the older age groups compared with the group of younger individuals, except for subjects with pronounced hearing loss. The result indicate that an age related dysfunction of the auditory pathway in the brainstem can be present in presbycusis.

Sturzebecher and Werbs (1987) studied the age and sex dependence of the latencies and interpeak latency (IPL) of the auditory brain stem responses. The latencies of the wave I, III and/V as well as the interpeak latency (IPL) I-V, and III-V are significantly shorter in females than in males. The latenci of I, III and V in males and for the wave V latency in females could be down on a correlation linear dependence on age. The slopes of the regression lines for the dependence of ABR latencies I, III and V on age tend to doe steeper in males than in females.

Of recent, a study of ABR in the elderly subjects demonstrated a shift in the latency of the single waves, reduced amplitude, shape changes, worsened reproducibility and increase central conduction time. Fujikawa 1977; Rowe, 1978, Jerger and Hall,1980 Quaranta,et al 1989).

Brain stem electric responses (BSER) to clicks at 80, 60, and 40 dB SL(rate 22.5/sec) were recorded from 62 normally hearing subjects grouped according to sex and age. There were four groups, young female (mean age 26.8 years) old females (56.1 years); young males (29.6 years), and old males (59. 3 years). The BSERs were measured in respect to peak latencies (I, III, V) and interpeak intervals (I-III, VII-V, I-V). Wave replicability was seen to deteriorate with age, concerning peak latencies, highly significant differences were established between the group of young females and the other three groups, your females exhibiting shorter latencies (of the order of 0.2 msec), Differences between the other three groups were less significant or nosignificant at all. Concerning interpeak intervals, the differences between groups showed little or no significance.

Furthermore, in old subjects only the individual III-V interva] exhibited a significant increase with reduction of click intensity from 80 to 60 dB SI_s of theorder of 0.1 m.sec. Variances of peak latency and interpeak interval measures were not seen to differs significantly between groups. (Rosenhamer, Lindstrom and Lundborg, 1980).

Rowe (1978) and Beagley and Sheldrake (1978) have investigated the effect of age and sex upon wave latencies. Rowe (1978) demonstrated significant differences between old and young subjects, white Beagley and Sheldrake found significant differences regard to sex, but not in regard to age.

James, Jerger (1978) Hall (1978) studied the amplitude and latency of the auditory brain stem responses waveform as a functions of chronological age in male and female subjects. They reported age had a slight effect on both latency and amplitude of wave V. In subjects with normal hearing, latency increased about 0.2 ms. over the age range from 25 to 55 years. In the same group, wave V amplitude decreased about 10%. In the subjects with sensorineural hearing loss, the latency increase was smaller but the amplitude decrease was equivalent. Sex also affected the AB^R. In both normal and hearing impaired subjects, females subject showed consistently shorter latency and larger amplitude at all age levels. Wave V latency was about 0.2 ms shorter and wave V amplitude was about 25% larger in female subjects.

Beagley and Sheldrake (1978) studied brain stem evoked potential to clicks at different intensity level (60, 70 and 80 dB) in a group of 70 normally hearing subjects (male and female) for each of decades from the second to the eight.

The result indicated that there was no increased in latency as a function of age. In females latencies were shorter than males subjects of all ages. The amplitude were reduced in case of older subjects. The tendency for amplitude to diminish with age, until in the 8th decades 50% of cases had an amplitude of greater than and equal 0.20 /uV and 50% of less than 0.20 /uV. They speculated two possible explanation about the cause of the amplitude diminition with age. Lack of synchrony between individual responses fallowing individual click stimuli. The mean latency of wave V from trial to trial and subject to subject did not show very great changes so it is necessary to postulate a greater scatter of individual response latency, and thuspoor syncrhony with increasing age. Increased tissue impedance may have played a part in the dimini of amplitude in the older subjects.

Keith, Graville (1987) reported in high frequency losses wave V is delayed at low intensities. Wave I tends to be delay at different intensities and by a greater amount than wave V. The I-V interpeak latency interval is often reduced with the effect maximal at higher intensities.

Von Wedel (1979) reported the percentage differences between young and older subjects which shows a decreasing wave occurrei with growing age. There will be an absence of the II, III and V wave complexes with increasing age at low intensity level (30dBHL). There was growing wave latency with age. The amplitude values show no significant age dependency. He concluded that a reduction 6f excited nerve fibers and reduced transport processes, in all regions in the pathway up to the nucleus of the lateral lemniscus with growing age.

Middle latency components: Mc Randle, Smith and Goldstein, (1974), Goldstein and Mc Randle (1976), Mendal et. al., (1977) have reported that there is little difference between adult and infant morphology for middle components, as a function of intensity, or rate of stimulus presentation. Neonates demonstrate slightly shorter latencies and smaller amplitude than do adults. In hearing impaired individual. Mc Farland et. al., (1977), Vivion et. al., (1979) have found systematic and reliable differences in the middle latency wave forms compared to normals at the same suprathreshold intensity level.

Linzi A, Chiarelli G, Sambetaro G (1989) reported changes in all their parameters of middle latency response (MLR) of the elderly subjects deterioration of the performance of waves, worsining of reproduclbillty latency shift of the single peaks with increased central conduction time, remarkable inter and intra individual amplitude variation. A significant shift in the absolute latency of waves, in particular of P_a which appeared most reliable index. For peak N_a, a lower progression of the latency increase was observed as a function of age, where as for peak N_b a wide dispersion of data were demonstrated. The shorter latency of evoked potentials in the young female was remarkably reduced in elderly subjects.

Late-latency components: Maturation and maturity affect the latency of these components. They decrease in latency from birth to about 10 years of age, and lengthen thereafter. The amplitude increases in the childhood and then becomes stable, eventually decreasing with advancing age (Callaway and Halliday 1973, Ellingson, et. al., 1974, Hunderson et. al., 1978b).

Long-latency components : Latency of the P_3 components has been found to increases as a function of age of subject (Goddin et. al., 1978a)

Central Auditory Disorder

The hearing problem of elderly patients are exceedingly complex. In addition to loss in peripheral sensitivity central auditory aging also exists in the older person. The principal effect of peripheral sensitivity loss is a decrease in the ability to hear speech, the effect of central auditory aging is a loss in the ability to understand speech, especially in difficult listening situations. Peripheral effects reduce overall speech intensity but central effects restrict overall speech understanding.

Central auditory disorders and their resultant effects have been studied with test batteries designed to evaluate central auditory function at a specific level ofperformance (Jerger 1960, Jerger and Jergey 1975, Lynn and Gilory 1977).

A typical test battery include measures of neural transmission in the brain stem pathways, such as auditory brain-stem response (ABR) audiometry and tests of temporal lobe speech processing, such as a dichotic listening task. (Duane et al., 1977, Starr and Achor 1975, Calearo 1957, Ketz et. al., 1963).

Both histopathologic and behavioural studies suggest that age-related changes in the central auditory system occur as early as the fourth decade of age. (Bergman et. al., 1976). Histopathologically changes includes loss in neuronal population and accumulation of lipofucin, a cytoplasmic material through out the central auditory system. Accumulation of lipofusin in brain stem auditory nuclei begins in early middle age (Bondareff, 1977).

Brody (1955) reported a reduction of more than one half in the cells of the superior temporal gyrus (the primary auditory area) over the age range from 20 years to 75 years.

Behavioural studies of 'sensitized' (distarted speech) materials also suggest that central auditory aging begins in the age decade 40 to 49 years.

Bergman (1971) evaluated the performance of subjects ranging in age from 20 to 80 years for a variety of speech materials including unaltered speech, reverberated speech. Overlapping speech and interrupted speech. Performance for all forms of distorted speech started to decrease in the decade 40 to 49 years. Performance for unaltered speech did not show substantial decreaments, until 70 to 79 years*

Konkle et. al. (1977) found a difference in performance for time compressed, monosyllabic words of over 20 percent between subject of the average age 57 years and 78 years. The difference in performance between 57 year old subject and 21 year old subject was less than 20 percent. The performance changed less in the 86 years span from 21 to 57 yea than in 20 years span from age 57 to 78 years.

Gaeth (1948) observed a disproportionate loss in intelligibility for common words in hearing impaired subject age 60 and older. This phenomenon was most prevalent in subjects with moderate to severe hearing losses, but it was also associated with advancing age,

Pestalozza and Shore (1955) showed that performance for monosyllabic phenamically balanced (PB) words for subject age 60 years and higher was 20% to 40% poorer than performance of subject age 50 years and younger, in spite of control for degree of sensitivity loss.

An increase in speech understanding ability withage is not the result of peripheral hearing loss. In spite of rigorous control for sensitivity loss elderly subjects continued to exhibit a disproportionate loss in speech intelligibility.

Jerger (1973a) studied single word intelligibility as a function of age with hearing loss constant in 2000 patient ranging in age from 6 to 89 years. He found at any level of sensitivity loss, there was a systematic decrease in performance for PB words with increasing age.

Calearo and Lazzaroni (1957) reported that altering speech rate severely affected speech understanding ability in the elderly. They presented simple sentences of approximately two and one half times faster than the normal rate.

Young subjects showed no performance decrements in this condition, but elderly subjects exhibited a decrease in performance.

Bergman (1971) found deterioration of performance for temporally distorted speech material in subjects aged 40 to 49 years and older. He used a number of speech materials, including unaltered, overlapping and interrupted words and sentences. Performance for all material decreased as a function of age, but decreament were greater for interrupted speech.

Konkle et. al. (1977) observed that intelligibility for time compressed, monosyllabic words decreased as a function of increasing time compression and age and decreasing sensation level. In spite of strict control for degree of sensitivity loss, the performance of subjects age 54 to 84 years systematically decreased as age increased. They concluded that "changes in speech intelligibility associated with the aging process appear to be closely allied to changes in temporal resolving power of central auditory processing system."

Speech understanding declines progressively with age. It has been assumed that this decline could be explained by the concomitant progressive decline in the auditory sensitivity with age. In recent years some investigators have suggested that at least a part of decline may be the result of age related changes in the central auditory system rather than in the auditory periphery.

Several investigators have revealed poor performance among the elderly on measures of speech understanding involving time altered speech (Bergman, Blumfild 1976, Konkle et. al., 1977, Mc Croskey et. al., 1982, Schmitt and Corrol, 1985) and sentences against a background of speech competition (Dubno et. al., 1982, Jerger et. al., 1977a, Mc Candless 1982). Such deficit in speech understanding are not confined, however, to the elderly. Similar finding has been noted in patients with focal brain lesions affecting the auditory pathway sin the central nervous system. The nature of central auditory processing disorder (CAPD) in such patients is a deficit in speech understanding that cannot be explained on the basis of peripheral sensitivity deficit (Jerger and Jerger 1984). Similarity in the patterns of result between brain lesioned and elderly individual has led to the hypothesis that age related changes in the central auditory pathways produce central auditory processing disorder (CAPD) in the same manner as known lesion of the central auditory system (Heyes and Jerger 1979, Stach et. al., 1985).

This hypothesis is supported from the evidences of progressive structural changes in central auditory system with increasing age. Histopathologic and morphologic studies have demonstrated age related alteration in the auditory nerve and the central auditory pathways at both the brain stem and temporal lobe levels (Schuknecht, 1974, Hinchcliff 1962, Corso 1977).

The senescent changes are not only confined to the auditory system. There is considerable evidence that certain cognitive abilities declined progressively with age as well (Salthouse 1985). Age related decline have been observed in working memory, episodic memory and speed of information processing.

The age related deficits in cognitive abilities might explain much of the age related decline in speech understanding. The performance on speech audiometric measures depend on such factors as memory, sementic knowledge, perceptual organization and attention, deficit in these areas might explain the depressed speech audiometric scores whether elderly patients with deficit in speech understanding do show related cognitive deficits that might explain poor performance on tests of speech understanding. There may be three explanation for the decline in speech understanding with age. Firstly, the age related changes in the auditory periphery could account for changes in speech understanding (Johnson and Hawking 1972, Model 1981). Secondly, aging in the central auditory pathways leads to a specific central auditory processing deficit whose impact on speech understanding add to the problem produced by peripheral sensitivity loss. Thirdly, possibly is that deficit in speech understanding not explicable by peripheral sensitivity loss might be explained by concomitant changes in those cognitive abilities important to tasks involved in measures of speech understanding.

Jerger et. al.(l989) studied the auditory and cognitive status in 130 elderly persons in the age range from 51 to 91 years. The prevalence of central auditory processing disorder was 50% and the prevelance of cognitive deficit was 41%. Results in the two areas were congruent, in only 63% of the total sample. Central auditory status was abnormal in the presence of normal cognitive function in 23% of the subjects. Central auditory status was normal in the presence of cognitive deficit in 14% of the subjects. In general, results did not support the hypothesis that declines in speech understanding in the elderly can be explained as a consequence of concomitent cognitive decline.

Indian Studies:

Kapur (1967) surveyed the hearing sensitivity in Todas a tribal population living in the hilly regions of Nilgiris.

This tribe had minimal exposure to noise, they neither used weapons like guns for hunting, nor did they use any musical instruments for entertainment. Hearing measurements were conducted in a mobile/ambulance, with ambient noise level of 40 dB (C scale). Total number of subjects included, 50 males and 43 females, of age ranging from 6 years to 70 years. The analysis of the results revealed normal hearing in 74% and hearing loss in 26% of the test population. Of the latter, 25% had conductive loss and only 1% manifested sensorineural hearing loss.

To study the characteristics features of presbycusis Kapur (1967) collected once more sample comprising of 31 males and 29 females. The value given by Glorig et. al., (1957) for the 10 to 19 years age group, was used as reference zero and data were analysed. The analysis of data revealed a slight elevation of threshold with age, in males but not observed in females. The changes in threshold in males was maximum at 250 Hz, 500 Hz, 6000 Hz and 8000 Hz. The general trend revealed better mean bearing level in females, compared to males at all frequencies except at 2000 Hz. Analysis of median thresholds, revealed better hearing in females at all frequencies except 2000 Hz & 8000 Hz Comparison of median threshold of male and female Todas with Mobaans, revealed better hearing in Todas, at all frequencies except at 6000 Hz in male and female. The findings of the above study cannot be accepted without reservations as the criterion used for the selections of subjects for presbycusic study has not been specified. The statistical measures employed are not specified and the conclusion are based on analysis of means and median values. This being a field study the finding are not comparable to strictly controlled laboratory studies.

Seth and Kocker (1971) assessed the level of hearing in a samples of 100 subjects, ranging in age from 5 to 77 years. The subjects for the study comprised of student populations and patients visiting the out patient sections of the All India Institute of Medical Sciences, New Delhi and the relative of the patients. The criteria used for selection was a negative history of ear pathology, complaint of hearing loss or dizziness. Hearing measurement were conducted at 8 frequencies 125 Hz to 8000 Hz in both ear of each subjects. The subjects were categorised into 8 age groups, with a class interval of 5 years. The result of the study, revealed a gradual increase in the loss of hearing with increasing age especially after fourth decade of life. The hearing loss was more marked at high frequencies while the speech frequencies were preserved. This study has a number of drawbacks. The criteria for selection of subjects was very less. Exposure to noise, which exerts the most contaminating influence on presbycusis values, has not been ruled out in the study sample.

As a majority of subjects were from the patient populations, the influence of other ailments on hearing is probable. Thus the values obtained do not reflect purely the effects due to aging. The number of subjects has not been maintained constantly in the various age groups. Only data for the two age groups (11 years to 20 years) and (61 years to 70 years) were analysed, in detail, and for all others only median and rays was computed. The statistical measures employed has not been specified, and all the conclusions are based on median threshold values for each group.

Babu Punnan (1976) has made an attempt to study the natur and degree of hearing loss in the aged population. He selected a sample of 100 subjects of age ranging from 35 years to 74 years from the attendants of patients, reporting at a speech and hearing centre. The subjects were categorised into 4 age groups, comprising of 25 subjects in each. All the subjects were otologically screened prior to testing. Hearing measurements were conducted in a sound treated room, at frequencies ranging from 250 Hz to 10,000 Hz at octave intervals for both the ears. The analysis of date revealed a gradual increase in hearing loss with age and frequency. The onset of hearing loss was reported to be earlier by about 5 years compared to western reports. This study has a number of limitations, which limits its applicability. First apart from otological screening, the criteria used for the selection of subject and the six representations of the sample has not been specified. These two factors are most important, as they have a significant effect on the age related changes of hearing acuity. The only statistical measures reported in the study are the mean, median and standard deviation scores. Details of the statistical analysis has not been given. The utility of the study is limited due to inadequate statistical analysis.

Indrani R (1981) studied the age and sex variation if any, in hearing by air conduction , among a group of subjects Indian nationality, A sample of 180 subjects of ace ranging from 10 years 6 months to 87 years were selected randomly from the general population. The sample was categorised into six age groups (10.6 yrs to 20.6 years, 20.6 yrs. to 30.6 yrs., 30.6 yrs to 40.6 yrs, 40.6 to 50.6 yrs., 50.6 to 60.6 yrs., and 60.6 yrs. and above). Background information to rule out the history of middle ear pathology, ototoxicity, noise exposure was obtained for each subjects. Air conduction pure tone autiometry testing and impedence autiometric testing was done for each subject in sound treated room. The results obtained were as follows: Hearing threshold increased as function of age. The six differences in thehearing acuity was not significant across most of groups and frequencies. In the age group of 50 years 6 month to 60 years 6 months a significant six differences was obtained at 500 Hz. only in the left ear. The dependency of hearing acuity on frequency was most marked in the older groups compared to the younger age groups. The ear differences was not found to be statistically significant. The variables was found to be more at high frequencies and in older age groups.

Krishnamurthy (1987) conducted the study to examine the changes in latencies and amplitudes in the geriatric population with near normal hearing. Ten subjects (7 male and 3 female) with age ranging from 52 to 71 years were taken for the study. These subjects were tested for brain stem evoked responses (BSER) using evoked response audiometry (ERA) model TA-1000 at 80 and 100 dB logon stimuli for 2, 4 and 6 KHz in right ear for 2048 samples at the rate of 20 stimuli/second; The latency (in ms) and amplitude in (uV) of each identifiable waves (I through V) were obtained for all the subjects. The results obtained were as follows. There was an increase in latency in all the five waves as the intensity of the stimulus was reduced from 100 to 80dB Hz. The increase in latency of all the five waves was greater than 0.2 ms. at 2, 4 and 6 KHz when the stimulus was reduced from 100 to 80 dB Hz. The latency values obtained in the geriatric population were longer than those obtained in the adult population. The over all latency differences exceeds 0.1 ms. More than 50% of the cases showed small (less than 0.2 /uV) amplitude in the geriatric group. Amplitude values of I and I waves obtained in the geriatric group were smaller than those obtained in the adult group (at both 80 & 100 dB Hz levels).

METHODOLOGY

The methodology of the nresent study is described under the following headings.

1. Subjects
2. Test environment
3. Equipment
4. Procedures

SUBJECTS: Total fourty subjects with equal number of males and females (5 male and 5 female) in four age groups i.e., 20 to 29 years, 50 to 59 years, 60 to 69 years and 70 to 79 years were selected for this study. All the subjects reported no difficulty in conversation in quiet environment.

The subjects were selected based on the following criteria:

1) They should not have any history of hearing loss, chronic ear discharge, tinnitus, giddiness or any other otological complaints.
2) They should not have family history of hearing loss.
3) They should not have any history of epilepsy or other neurological complaints.

4) They should not have history of noise exposure and consumption of ototoxic drugs i.e., streptomycin, kanamycine, neomycine, etc.

5) At the time of study they should not be under any medication.

TEST ENVIRONMENT: The experiment was carried out in sound treated control cum test room, combination. The noise measured using sound level meter (B & K 2209) coupled with an 1/2" condensor microphone (B&K 4165) with the associated octave filter set. The noise level were found to be sufficiently low as not to interfere with the test results (Appendix - 3) .

EQUIPMENT: For the purpose of obtaining pure tone thresholds, a dual channel clinical audiometer (Madsen OB 822) with ear phone (TDH 39) set in supreoural cushions (MX 41/AR) was used for all the subjects.

An impedence audiometer (Madsen ZO 174) equipped with earphones (TDH 39) set in supraaural cushions (MX 41/AR) was used for impedence measurement. The

Auditory brain stem responses was r-corded using evoked response audiometer (Nicolet compact auditory system).

Calibration: The audiometer was caliberated for pure tone and speech noises as per ISI (1973) standards. Prior to each test session. Details of calibration procedures given in appendix- C .

PROCEDURE: A detail case history was obtained in quite room before going under audiological investigation.

Pure-tone Testing: Pure-tone thresholds were obtained using the modified Hughson-Westlake procedure (Carhart and Jerger 1969). The pure-tone thresholds were obtained for frequencies ranging from 250 Hz to 8000 Hz at octave intervals. Thresholds for air conduction were obtained for both right and left ears.

Prior to the commencement of the testing, the instruction given to the subject were as follows:

"I am going to test your hearing by presenting different kinds of tones to your ear, throughthe earphones. First the tone will be presented at the level you can hear well. As soon as you hear the tone, raise your finger and hold it up as long as you hear the tone. As soon as you stop hearing the tone, put the finger down immediately. The level of the tone will be varied each time. Even if you think, you hear the tone, you should raise your finger. If you don't hear the tone, don't raise your finger.

Impedance measurement: For each subject, Tympanogram, Static compliance and acoustic reflex threshold were obtained, for both the ear. Tympanogram was obtained with a 220 Hz probe tones for the both ear of the subject. Static compliance reading were noted down from the direct display on impedence audiometer (Madsen ZO 174). The both ipsilateral and contralateral acoustic reflex threshold were measured for frequencies ranging from 500 Hz to 4000 Hz at octave interval.

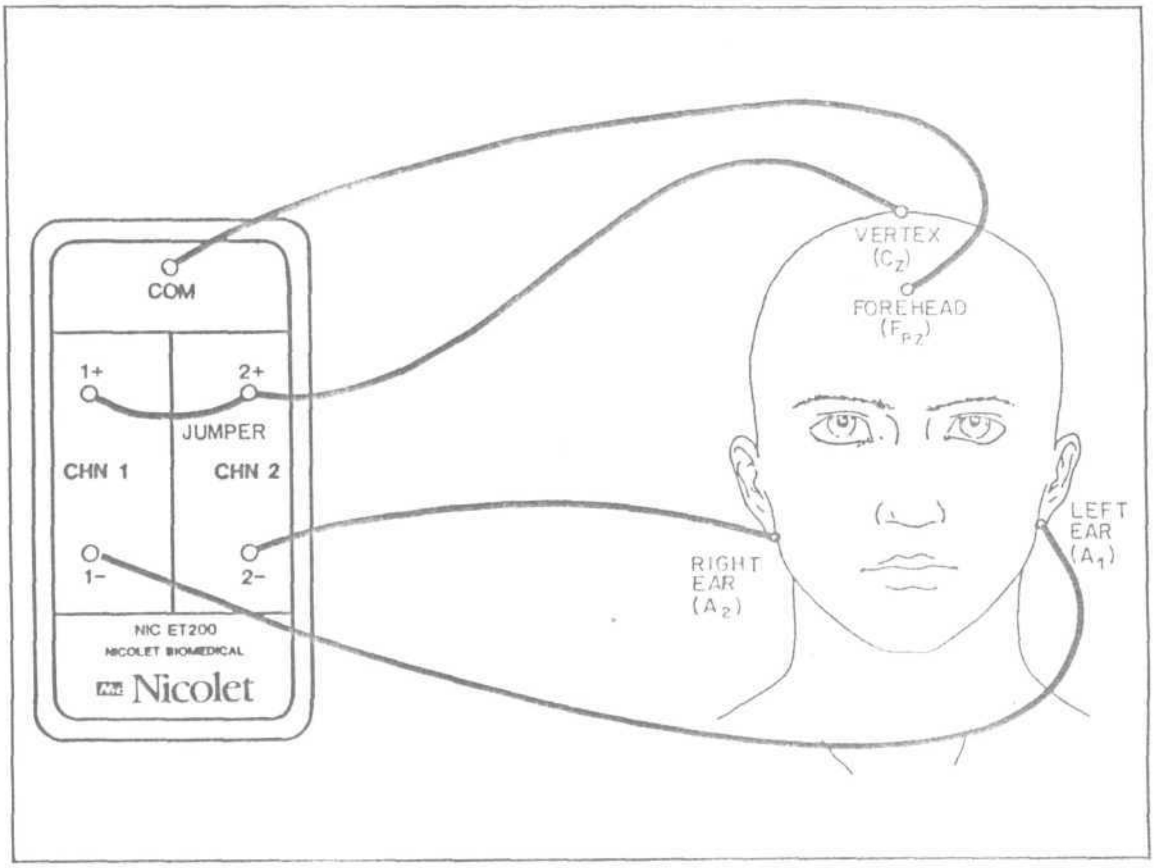
Auditory brain-stem response: Nicolet compact auditory system was used for recording the auditory Brain-stem responses (ABR). Cotton soaked in rectified spirit was briskly rubbed to clean the skin area where the electrodes are to be placed. The electrodes were placed with help of electrolyte gel. The adhesive plaster was used to hold the electrode into firm contact around. Electrodes placement were as follows:-

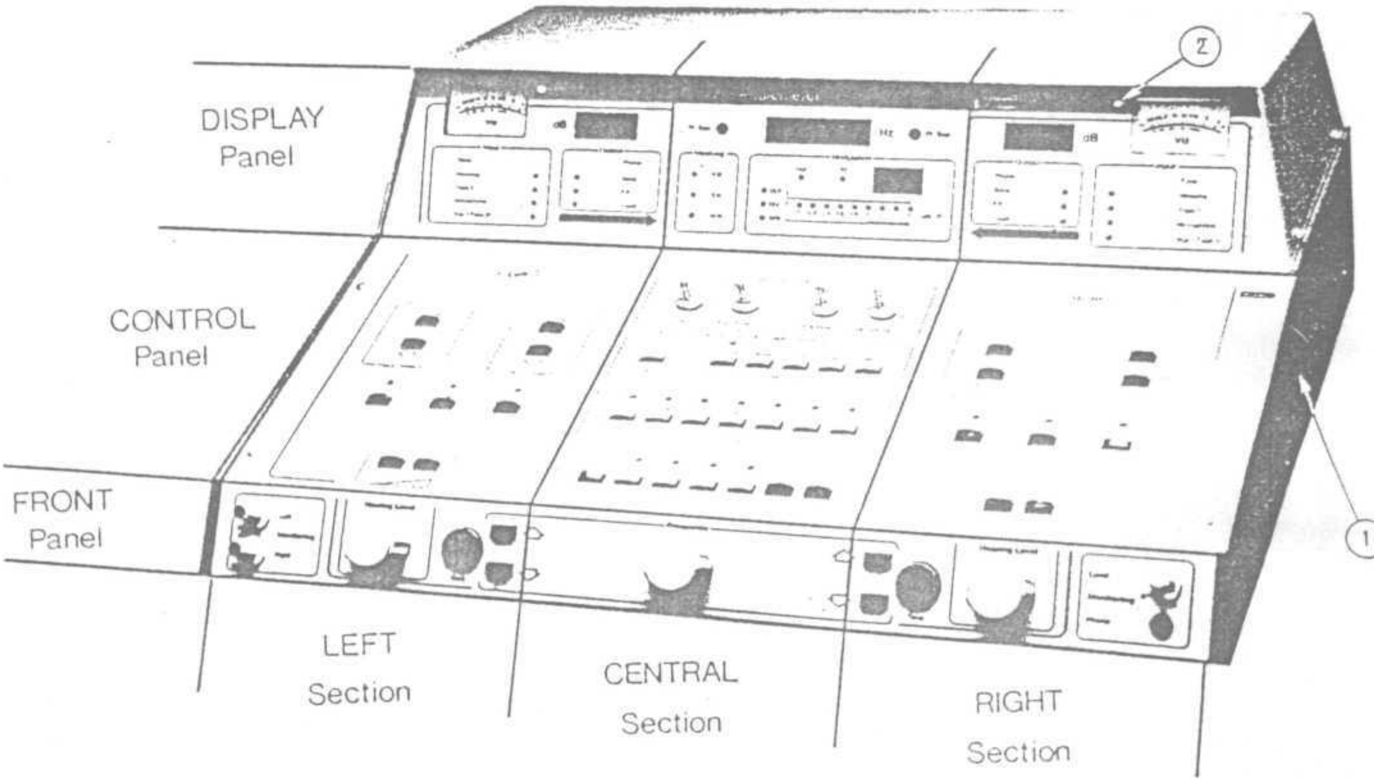
Common was placed on forehead (FPz)
Positive wasplaced on vertex (Cz)
Negative was placed on each mastold (Right A2; Left A1)

Electrode impedence was measured before the recording of auditory brain stem responces. All the electrode impedence should be less than 5 K.ohms at each point. The subject was asked to sit in reclining position comfortably on a chair. Subjects were instructed to relax and close his/her eyes. The stimuli clicks were presented through TDH-39 earphone in a MX 41/AR cushion. The clicks were presented at rate of 11.4/Sec. for 2000 sweeps at 75 dB stimulus intensity and responses were recorded. The filter setting 130 Hz (LFF) and 3000 Hz (HFF) were used in this study. The obtained data was stored on a disk and analysed latter. Peaks in the composite auditory brain stem responses have been identified visually and labelled. The absolute latency of peak I, III and V and interpeak latency I-III, III-V, I-V and amplitude - of Peak I and V have been measured.

Nicolet COMPACT AUDITORY

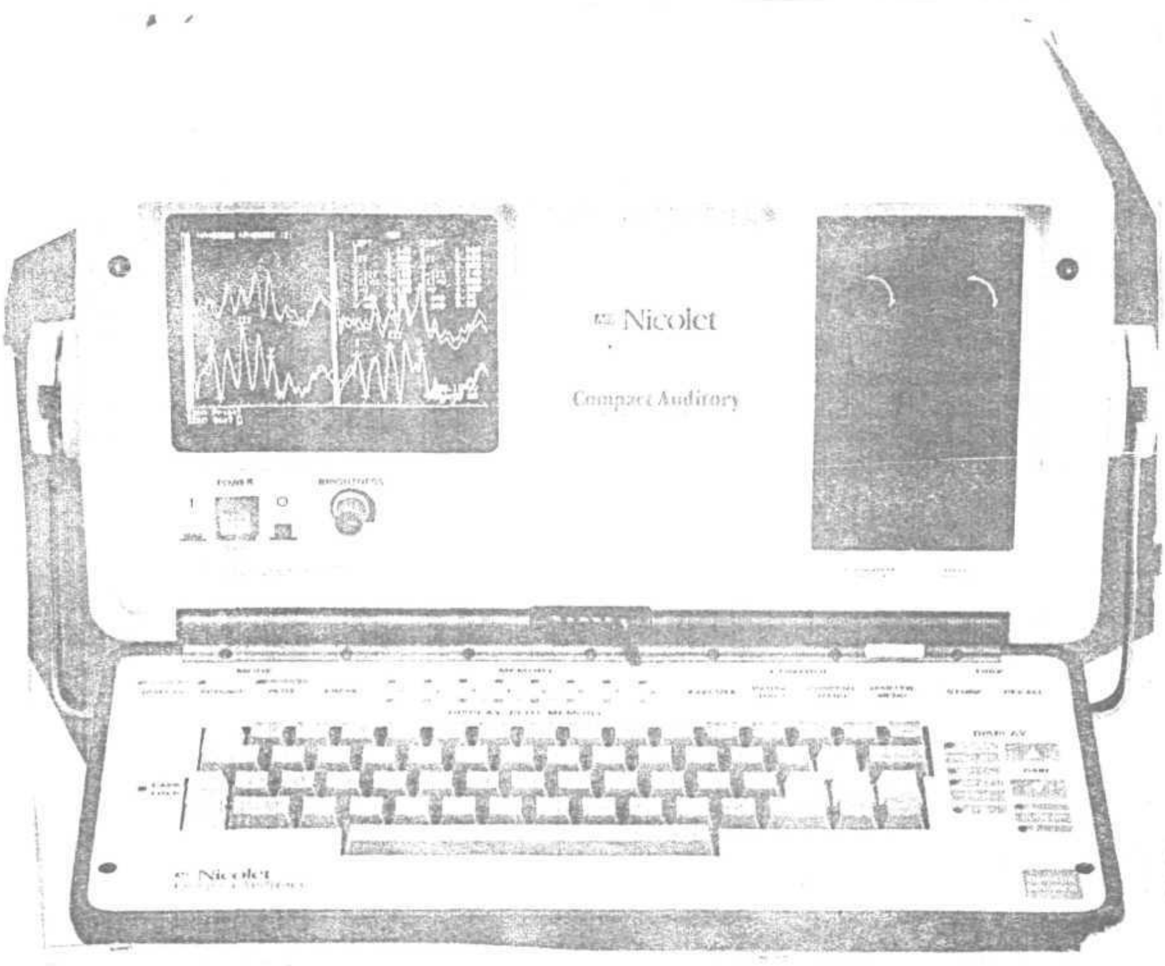
ELECTRODE CONNECTIONS FOR ABR POTENTIALS





CLINICAL AUDIOMETER (MADSEN-OB 822

IMPEDENCE AUDIOMETER (MADSEN ZO 174)



NICOLET COMPACT AUDITORY

RESULTS

In this chapter are presented the results of test- pure tone impedence and ABR. Results are presented in tabular form - mean, standard deviation and statistical analysis of data.

Pure Tone Audiometry:

Data was collected for air conduction pure-tone thresholds for 40 subjects (male and female) in the four age groups i.e., 20 to 29 yrs., 50 to 59 yrs., 60 to 69 yrs., and 70 to 79 yrs for both right and left ears, at seven test frequencies; 250 Hz to 8000 Hz, at octave intervals. This data was subjected to statistical analysis. Measures of central tendency (mean) and variability (standard deviation) were computed for each age group, for each ear, at all test frequencies for both male and female subjects. Mean values were computed for plotting the audiometric curves. These results are given in Table No.l to 4.

The 't' test was anplied at each frequency for all the age groups to determines and compare the age differences, sex differences and their interaction effects on hearing acuity. These results are presented in Table No. 5 to 7.

The audiometric profiles for males and females, for all age groups was prepared by plotting the mean threshold values for the respective age groups as a function of frequency. The profiles for the right and left ears are given separately.(Fig-1-8)

The analysis of data are given below:-

Age Variation:

The mean hearing thresholds are presented in table 1-4, reveal an increase in hearing threshold in the older age groups compared to the younger group (control group) for both male and female in both the right and left ear, in the whole sample.

The variability, computed from standard deviation revealed greater variability among the older groups compare to the younger age group for both male and female in both the ear.

The audiometric profiles comprising age curves and frequency curve, also shows an increase in hearing threshold with an increase in age in the geriatric age group and the increase in hearing threshold is maximally at higher frequencies (4 KHz, 6 KHz, 8 KHz) for male and female in both the ear, which is manifested by a horizontal and vertical shift in the audiometric centres for the whole sample.

The 't' test computed, at each frequency for right ear, for both males and females for each age group revealed a statistically significant age difference on hearing acuity for all the three older age group (50-59 yrs., 60-69 yrs., 70-79 yrs.,) compared with the younger age groups (20-29 yrs). That is, a significant increase in the hearing threshold was observed with age, across 611 frequencies in the right ear for both males and females.

Sex Variation:

The maximum hearing loss was at 8000 Hz for both males and females. The increase in hearing threshold in females was more compared to males, at lower frequencies, but at higher frequencies the increase in hearing threshold was more in males compared to the females (Table No. 1 to 4).

The standard deviation also showed an increase in variability with an increase in age in both males and females.

The audiometric profiles (Fig. 1-8) comprising age curves and frequency curves for males and females, does not show, a consistent sex differences, across frequencies and age groups.

The 't' test computed also failed to reveal a statistically significant sex differences at each frequency in all the age groups in the right ear. There was no statistically significant difference observed between male and female for all the frequencies.

Frequency variation:

The mean hearing thresholds, at the test frequencies, showed a more marked increase in the hearing level, with increasing age at higher frequencies, compared to lower frequencies.

The variability, commuted from the standard deviation revealed an increase in variability, substantially with an increase in frequency (Table 1-4).

The frequency curves for the various age groups,also shows a prominant, high frequency slope for both males and females, in both right and left ears in the older age groups.

The hearing acuity, was observed to very more as a function of frequency in the older age groups compared to the younger age groups.

Ear Difference:

The mean values computed for the two ears, in all the age groups and at each test frequencies failed to reveal a consistant ear difference.

The graphical representation of the scores for the two ears, was not very different for the right and left ears.

The results were not further computed for statistical analysis to observe sex differences also the results were not further computed for a statistical analysis to observe age differences, sex differences and the frequency differences for the left ear.

Impedence Audiometry

On impedence audiometry data was collected for static compliance, tymponemetry and acoustic reflex threshold for all 40 subjects in four age group comprising 20 to 29 yrs. 50 to 59 yrs., 60 to 69 yrs., and 70 to 79 yrs, for both right and left ear. Ipsilateral and contralateral acoustic reflex thresholds were obtained for 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz . This data was subjected to statistical analysis. Measure of central tendency, mean and standard deviation was computed for each age groups for each ear for both male and females.

The 't' test was applied for each measure i.e. static compliance and acoustic reflex thresholds at (500, 1000, 2000 and 4000 Hz) for all the age groups to determine and compare the age differences, sex differences and their interaction effect on hearing acuity. Tympenogram in both the ears showing'A'type was taken for other impedance measurements. All the forty subjects had type 'A' tympanogram in both the ears.

Static compliance:

The mean value of the static compliance presented in the table-15, reveal a decrease in the static compliance in olderage groups compare to younger age group, for both male and female in both the right and left ears in the whole sample.

The standard deviation revealed greater variability among the older groups compare to the younger age group for both male and females in both the ear.

The 't' test computed for each group of males and females for the right and left ears revealed no statistically significant age differences. Also there was no statistically significant difference found between male and females and between the two ear on static compliance measures.

Acoustic Reflex Threshold

Age variation: The mean value of acoustic reflex thresholds presented in Table-g-11, reveal an elevation (Increase) in the ipsilateral and contralateral acoustic reflex thresholds in older age groups compared to younger age group (20 to 29 yrs) for both male and female in both the right and left ears except at 500 Hz.

The standard deviation revealed that there was not much variability among the older age groups comnared to the younger age group.

The 't' test done at each frequency (500 Hz, 1000 Hz, 2000 Hz and 4000 Hz) for the right ear for each age groups both ipsilateral and contralateral acoustic reflex threshold for both males and females revealed a statistically significant age difference on acoustic reflex threshold in older age groups (70 to 79 yrs) compared with younger age groups (20-29 yrs).

That is a significant increase in acoustic reflex threshold was observed with increasing age, across all four test frequencies (500 Hz, 1000 Hz, 2000 Hz and 4000 Hz) in right ear for both males and females. However, there was no statistically significant difference found among the various age groups for females on ipsilateral acoustic reflex threshold at 1000 Hz.

Sex differences

Both ipsilateral and contralateral acoustic reflexes were absent at 4000 Hz in both the males and the females in the older age groups.

The variability, computed from standard deviation revealed not much variability among the olderage groups compared to the younger age groups.

The 't' test computed, also failed to reveal a statistically significant sex differences between male and female for ipsilateral and contralateral acoustic reflexes at each frequency for both younger age group and older age groups.

Frequency Variation

The mean ipsilateral and contralateral acoustic reflex threshold at the test frequencies showed a more marked elevation in acoustic reflex threshold with increasing age at all the frequencies.

At 4000 Hz both ipsilateral and contralateral reflexes were found absent in the older age groups.

No significant differences was found at 500 Hz for both ipsilateral and contralateral acoustic reflex thresholds for both male and female subjects between older subjects compared to the younger subjects. At 2000 Hz, statistically significant difference was found on ipsilateral and contralateral acoustic reflex threshold for both sexes in the right ear for older age groups 50 to 59 yrs, 60 to 69 yrs and 70 to 79 yrs. as compared to the younger age group (20-29 yrs).

Ear differences:

The mean values computed for the two ears, in all the age groups and each test frequency, failed to reveal a consistent right and left ear differences on both ipsilateral and contralateral acoustic reflex thresholds.

The results were not further computed for statistical analysis to observe ear differences.

Brain-stem Evoked Responses

Brain-stem Evoked Response data was collected for different peaks latencies (I, III and V) and inter peak latencies (I-III, III-V, I-V) and amplitude for I and V peaks. For all 40 subjects in four groups, comprising 20 to 29 years, 50 to 59 years, 60 to 69 years and 70 to 79 years, for both right and left ear, each tested for click stimuli at 75 dB nHL (using 11.4 stimuli(click)/sec). This data was subjected to statistical analysis. The means and standard deviation was computed for each age groups, for the both ear (right and left) for both males and females.

The 't' test was applied for different peak latencies (I, III and V) interpeak latencies (I-III, III-V, I_V) and amplitude for I and V peaks for all the age group to determine and compare the age and sex variation. On different peak latencies, interpeak latency and amplitude.

The analysis of the data has been given below:

Age Variation on Latency:

The mean latency for peak I, III and V presented in table 18-21 , reveal an increase in latency in older age groups compared to younger age groups for both male and female, except the mean latency for peak V was greater for female in the right ear in age group 50 to 59 years, compared to age groups 60 to 69 and 70 to 79 years.

The standard deviation revealed greater variability among the older groups compared to the younger group for both sexes.

The ' t' test computed, for the different peaks, for right ear, for both males and females, for each group revealed statistically significant age differences (at .05 level) for all the three peak latencies (I, III and v) for all the three older age group (50-59, 60-69 and 70-79 yrs) groups compared to the younger age group (20-29 yrs). However, there was no significant difference for I peak latency between age groups 50 to 59 years and 60 to 69 years compared to younger group (20-29 yrs) for females.

For males no significant difference for peak I latency was found between older age group(50 to 59 yrs) compared to younger age groups (20-29 yrs) also no significant difference was found for latency of peak V in female, between older age group compared to younger age group.

The mean latency for peak V was lesser for females with males for all the age groups.

Sex difference

The mean latency value for peak V was considerably longer for male than the female for the all age groups.

The variability computed from standard deviation revealed greater variability among older groups compare to the younger groups for both/dale and female.

The 't' test computed failed to reveal a statistically significant sex differences for I and III peak latency for all the age groups for the right ear.

However, the 't' test revealed a statistically significant sex difference for peak V latency, except the 50-59 yrs. age groups.

For peak V latency, a statistically significant difference was found among females of older age groups compared with the younger age groups. However, statistically no significant differences was found on peak V latency among males of older age groups compared with younger age group.

Age variation:

Inter-peak latency:

The mean interpeak latency value for I-III, III-V and I-V are presented in table. 18-21, does not reveal any considerable changes in the older groups compared to the younger group.

The 't' test computed, for interpeak latency (I-III, III-V and I-V) revealed no significant age differences for all the older age groups compared to younger group.

Sex differences in Inter-peak latency:

The mean interpeak latency of I-III, III-V and I-V presented in the table, reveals a greater differences in males than in females i.e., mean interpeak latency (I-III, III-V, I_V) was considerably greater for male than female for all the age groups.

The 't' test computed for interpeak latency (I-III, III-V, I-V) revealed no significant sex differences for all the age groups except 60-69 yrs. age group for I-V inter peak latency, compared to younger age 20-29 yrs.

Age variation in Amplitude

The mean amplitude value for peaks I and V presented in the table, 18-21 reveal a lower amplitude value for the older age groups compared to the younger age group i.e., a decrease in amplitude value as the age increases was observed.

D I S C U S S I O N

The results of the present study are discussed along the following lines.

Acre variation

Pure tone Audiometry: The results obtained in the present study revealed an increase in hearing thresholds in older (geriatric) age groups (experimental group - 50-59, 60-69 and 70-79 yrs) compared to younger age group (control group - 20-29 yrs) in both male and female. The onset of hearing loss, as a function of age occurred in the 5th, 6th and 7th decade of life for bothmale and female. The elevation of hearing thresholds was more marked in 7th decade compared to Sthand 6th decade of life for both male and female. This general findings is in agreement with findings of most of several other studies. (Carso 1963; Goetzinger 1961, Sataloff, 1966, Glorig and Nixson 1962, Burn 1968, Milne 1977, Punnan 1976, Indrani 1981, Paderson et. al., 1989).

The results also revealed a statistically significant age difference on hearing threshold for geriatric (older age) groups compared with the younger age group.

Sataloff (1961) reported the incidence of hearing loss in the elderly population is significantly high and the most common cause of hearing loss is presbycusis or the loss of hearing due to the aging process. Bunch (1931) reported a change in hearing sensitivity, as reflected by the pure tone audiogram is the alternation in auditory function associated with aging process. He also reported gradually, progressive reduction in hearing sensitivity beginning at about age of 30 years.Corso (1963), also reported onset of hearing loss in 3rd decade. Since in the present study the geriatric (older age) group was taken about the age of 50 years, the reduction in hearing threshold beginning in 3rd and 4th decade is not reported.

Berger et. al. (1977) reported presbycusic deficit in many case is gradually sloping, gradually progressive, high frequency sensorineural hearing loss. The loss increases at first and their accelerates more rapidly with increasing ages, especially for the higher frequencies. The present study result shows the similar type of findings. Punnon (1976) and Indrani (1981) also revealed a deterioration in hearing acuity with increasing age. This finding is in agreement with the findings of the present study.

Impedance audiometry

The results obtained on static compliance in the present study revealed a slight decrease in static compliance in the geriatric (older age) groups compared to younger age group for both males and females. However, the results revealed no statistical age related differences for both males and females. The finding is in agreement with the finding of several other studies. (Jerger et. al., 1972, Hall, 1979).

Jerger et. al. (1972) reported a systematic decline in static compliance with advancing years. Static compliance involved the measurement of the compliance of middle ear in its resting or static state by determining the volume of air that has a compliance equivalent to that of the middle ear system.

Albert et. al. (1972) reported middle ear system becomes increasingly compliant up to middle age and then stiffen with further advance in age. Hall (1979) reported that the static compliance values was maximum between 31 and 40 years of age and then decreases relatively systematically with increasing age.

The results of acoustic reflex threshold measurement revealed an elevation in both ipsilateral and contralateml acoustic reflex threshold in the geriatric (older age) group compared to the younger age group. Both ipsilateral and contralateral acoustic reflex threshold revealed a statistically significant age differences for both males and females in the older age group (70-79 yrs) compare to younger age group (20-29 yrs). This finding is in agreement with the findings of other studies (Jerger et. al., 1972, Jerger et. al., 1978, Margolis, 1978).

Thompson et. al. (1980) reported growth in amplitude of the acoustic reflex to filtered noise and tones of GOO Hz 1000 Hz and 2000 Hz in 30 persons ranging in age from 20 to 79 years. Although threshold of the acoustic reflex did not vary significantly across the age range of the subject sample, the rate of growth in amplitude decreased linearly with an increase in decade. The result of this study does not support the result of the present study, the variability may be due to the different types of stimuli used to elicit the acoustic reflex thresholds.

Brain Stem Evoked Response:

The results obtained revealed an increase in the latency for peaks I, III and V in older age group compare to younger age group, for both male and female subjects. However, the mean latency for peak V was greater in age group 50 to 59 years old compared to other older age groups (60 to 69, and 70 to 79 yrs). There is an increase in latency with increasing age. A statistically significant age difference (at .05 level) was observed for the latency of the peak I, III and V, for all the older age group compared to younger age group.

The general findings of the present study is in agreement with the findings of several other studies (Coats and Martin 1977, Rowe 1978, Thompson et al., 1978, Jerger et. al., 1980).

The results of the interpeak latency (I-III, III-V and I-V) of the auditory brain stem responses revealed no considerable changes in older age group comnare to younger age group. Statistically no significant age differences were found in the older age groups.

Otto and Mc Candless (1982) found that the latency of wave V was slightly longer from the elderly subjects than for young ones. They found no consistant pattern of lengthened latency due to aging, after comparing the interpeak latency differences between different age groups. The present study supports the findings of Otto and Mc Candless results. Information regarding the influence of age on interpeak latency is contradictory. In contrast to the present study, Rosinhamer et. al.,(1980) found that the I-V inter peak latency was constant and independent of hearing loss and age. Also Maurizi et. al. (1982) found a significant prolongation of the I-V interpeak latency in old persons with -presbycusis indicating that age related changes involve that not only the end organs but also the brainstem structures. Moller and Blegvad (1976) reported sensorineural hearing loss affecting the high frequencies, results in a prolongation of all auditory brain stem response wave latencies. In the present study, the absolute latencies of the ABR waves (I, III and V) were longer in the group of older subjects than in the normal hearing younger subjects, which may be the result of sensorineural hearing loss at higher frequencies.

Sex Variation

Pure-tone Audiometry:

A deterioration in the hearing acuity with age was manifested in both males and females. The poorest hearing threshold was at 8000 Hz in both males and females of the all age groups.

The increase in hearing thresholds was greater in females compared to males at lower frequencies, but at higher frequencies, the increase in hearing threshold was greater in males compare to females.

A statistically significant sex difference was not observed at every frequency between all the older age groups and younger group. This findings is in agreement with the findings of several other studies (Mos Cicki 1985, Indrani 1981).

Moscicki et. al., (1985) reported in epidermiologic study of the Framinghom Heart Study Cohort. There were no statistically significant sex difference at 1 KHz and below was observed. Women had significantly better hearing than men at 2 KHz and above.

In contrast to the present study, Corso (1963) found a significant sex difference in his study of U.S. subjects age ranging from 18 yrs to 64 yrs. The hearing acuity in women was found to be more acute compared to that of men. Also he reported that the differences between the two sexes was most marked at high frequencies, but present study does not support this view. Sex differences was not statistically significant in present study.

Sex differences in hearing acuity has been reported in Todas, a primitive tribe in residing in the hilly regions of Nilgiris in India. The female Todas were found to have better hearing compare to male Todas (Kapur, 19671

Indrani (1981) found the age related changes in hearing seems to be common for males and females. The present study finding in agreement with the result of earlier finding (Indrani 1981, Moscicki, 1985).

Impedance Audiometry

The results obtained on static compliance in the present study revealed , statistically no significant sex differences for all the age groups. The present study finding in agreement with other findings (Jerger et. al., 1978). Hall (1979) reported distinct sex differences in static compliance values at all age levels except for patient 60 years and older. Below the age of 30 years, static compliance values were slightly greater in the female subject. For 31 to 60 year of age, however, the static compliance values for men were substantially greater. Above age of 60 years, average static compliance values for men and women were comparable. The sex differences in static compliance to be more pronounced between 30 to 60 year of age. Both men and women showed a systematic decline in static compliance beyond age of 30 years, which is attributed to changes in middle ear tissue muscles and ossicles. The results obtain on ipsilateral and contralateral acoustic reflex threshold revealed, statistically no significant sex differences at each tested frequencies (500 Hz, 1000 Hz, 2000 Hz and 4000 Hz) for both younger and older age groups.

Both ipsilateral and contralateral acoustic reflex was absent at 4000 Hz in both the male and female in the older age groups. (50-59 years, 60-69 yrs, 70-79 yrs).

Jerger et. al., (1978) reported a gradual reduction in acoustic reflex thresholds to tones of 250 Hz, 500 Hz, 1000 Hz, 2000 Hz in subject between the age of 20 to 59 years. The finding of present study is in agreement with earlier studies (Jerger, 1978).

Brain Stem evoked response

The mean latencies of the waves I, III and V as well as the mean inter peak latencies of I-III, III-V and I-V are significantly shorter in females than in males in younger age group as well as in the older age group subjects. However, statistically no significant sex difference was found for latency of peak I and peak III between the older age group (50-59, 60-69, 70-79 years) and younger age group (20-29 yrs). Also, statistically no significant sex differences were found for interpeak latency (I-III, III-V, I-V) between all the older age groups and younger age group. A statistically significant sex difference was found for peak V. Jerger and Hall (1980) and Thompson et. al., (1978) also reported a shorter wave V latency in females than in males. The result of the present study is in agreement with Jerger and Hall's study (1980). Sex differences in the auditory pathway length can play only a minor role, as they do not explain the increase in the latency difference between male and female in the geriatric population.

Frequency variation

Pure tone audiometry

A significant frequency variation on hearing acuity was observed in the geriatric groups. The degree of hearing impairment with increasing age was more at higher frequencies (above 2000 Hz) compared to lower frequencies (below 2000 Hz).

This findings is in agreement with the findings of several other studies (Goetzinger 1961, Corso 1961, Punnon 1976, Indrani 1981).

Corso (1963) reported that the hearing acuity was within 20 dB at low frequencies (250 Hz, 500 Hz, 1000 Hz, 1500 Hz) even in the the oldest age group. The results of the present study varies slightly from Corso's (1963) findings. In the present study the mean hearing threshold was less than 35 dB at lower frequencies than 2000 Hz in the older age groups, and the mean hearing threshold was more than 35 dB at higher frequencies above 2000 Hz. In all the three age groups (50-59, 60-69 and 70-79 yrs) slight involvement of low frequency was observed.

Fieldmen and Reger (1967) obtained results similar to the present study findings. In their study of subjects of age 20 years to 29 years and 50-89 years , they found a high frequency hearing loss in the 50-89 years age group.

Impedance Audiometry

The result of both ipsilateral and contralateral acoustic reflex threshold revealed a marked elevation in threshold with increasing age at all the frequencies (500 Hz, 1000 Hz, 2000 Hz). At 4000 Hz both ipsilateral and contralateral reflexes were absent in the older age group. This is mainly due to a greater amount of hearing loss at 4000 Hz compare to frequencies below 4000 Hz. For the test frequency 500 Hz, statistically no significant difference was found for both ipsilateral and contralateral acoustic reflex thresholds between the older age groups compared with the younger age groups. At 2000 Hz, statistically significant difference was found on ipsilateral and contralateral acoustic reflex thresholds in the right ear for older age groups (50-59, 60-69 and 70-79 yrs) compared with the younger age group (20-29 yrs).

This findings is in agreement with the findings of several other studies (Hall and Jerger, 1980, Silmen 1979).

Ear difference

In general, ear differences were not found in the present study. There was not much variability found in the mean pure tone thresholds and acoustic reflex thresholds at each frequency between the two ears. Therefore further statistical analysis was not computed to see the ear differences. This findings is in agreement with the several other findings (Corso 1963, Indrani 1981).

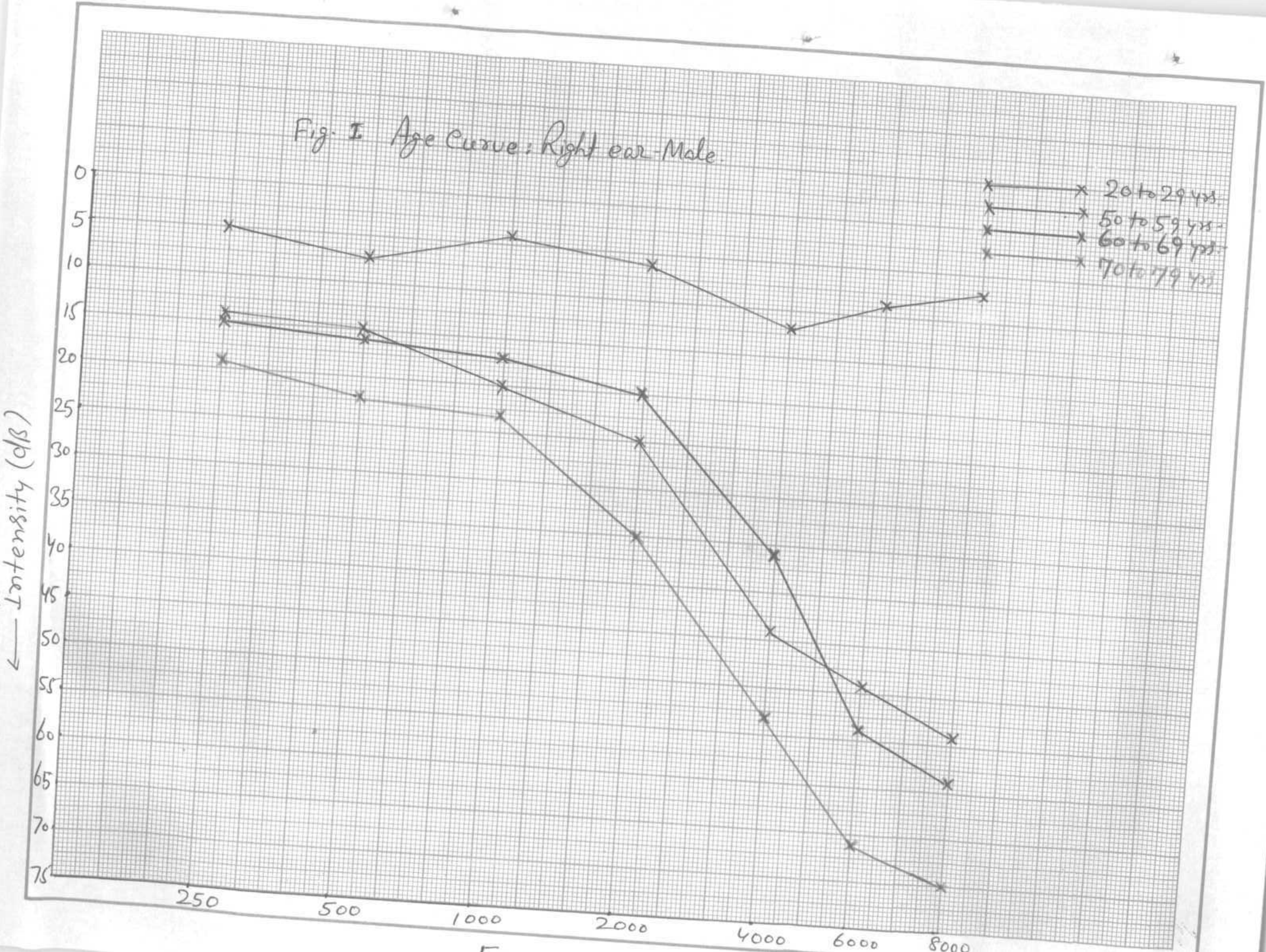


Fig. I Age Curve: Right ear-Male

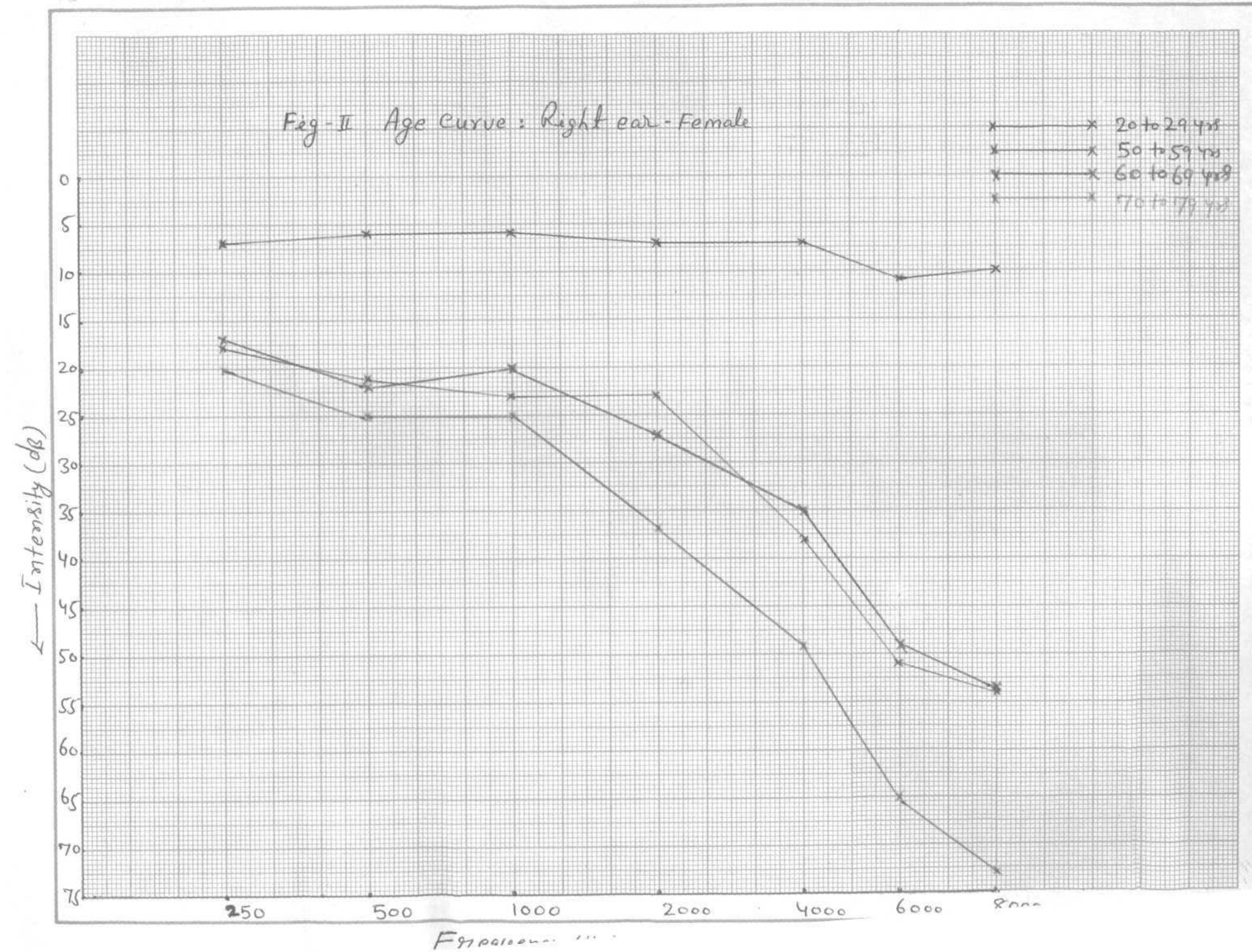


Fig - II Age Curve : Right ear - Female
20 to 29 yrs
50 to 59 yrs
60 to 69 yrs
70 to 79 yrs
Intensity (dB)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
250
500
1000
2000
4000
6000

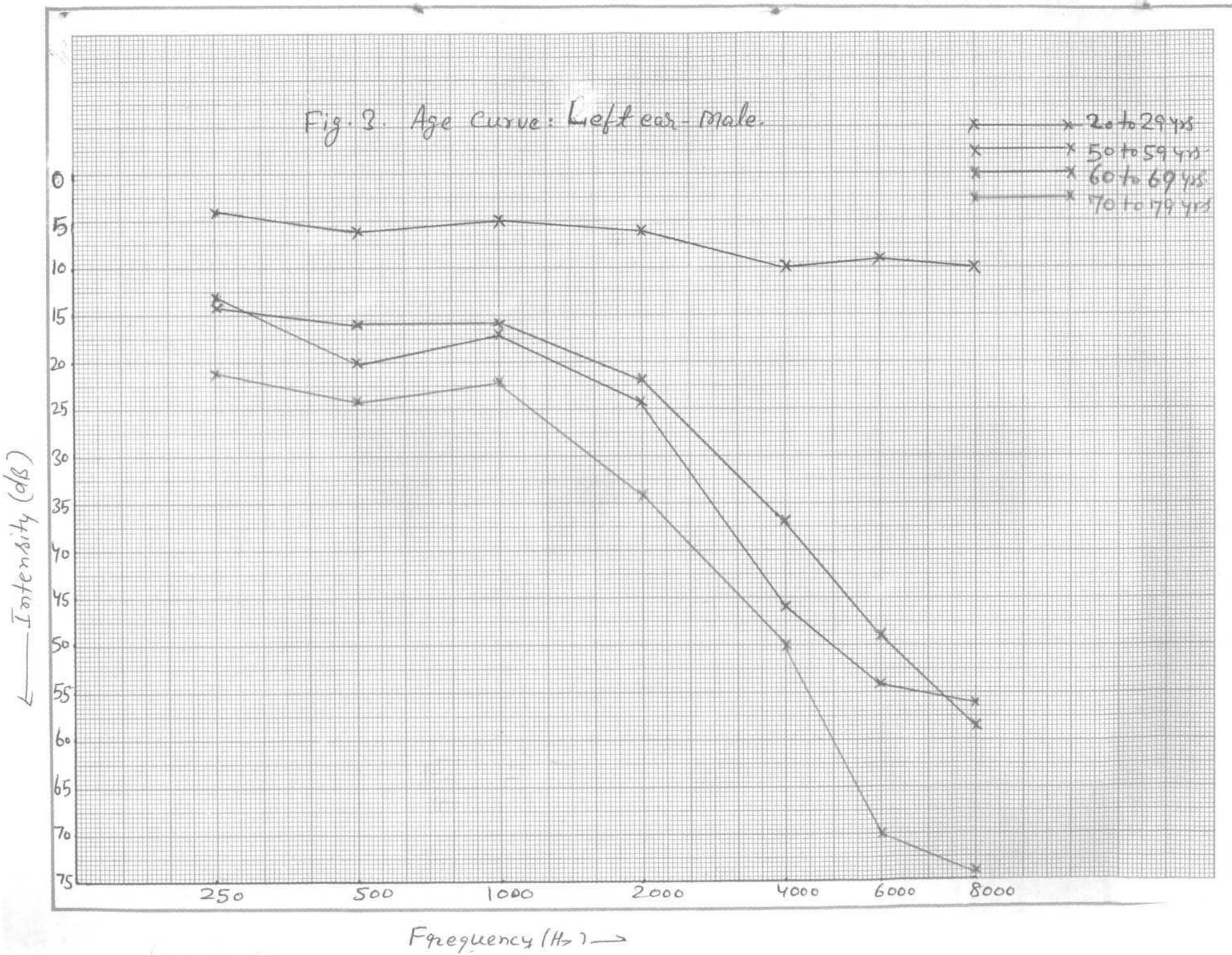
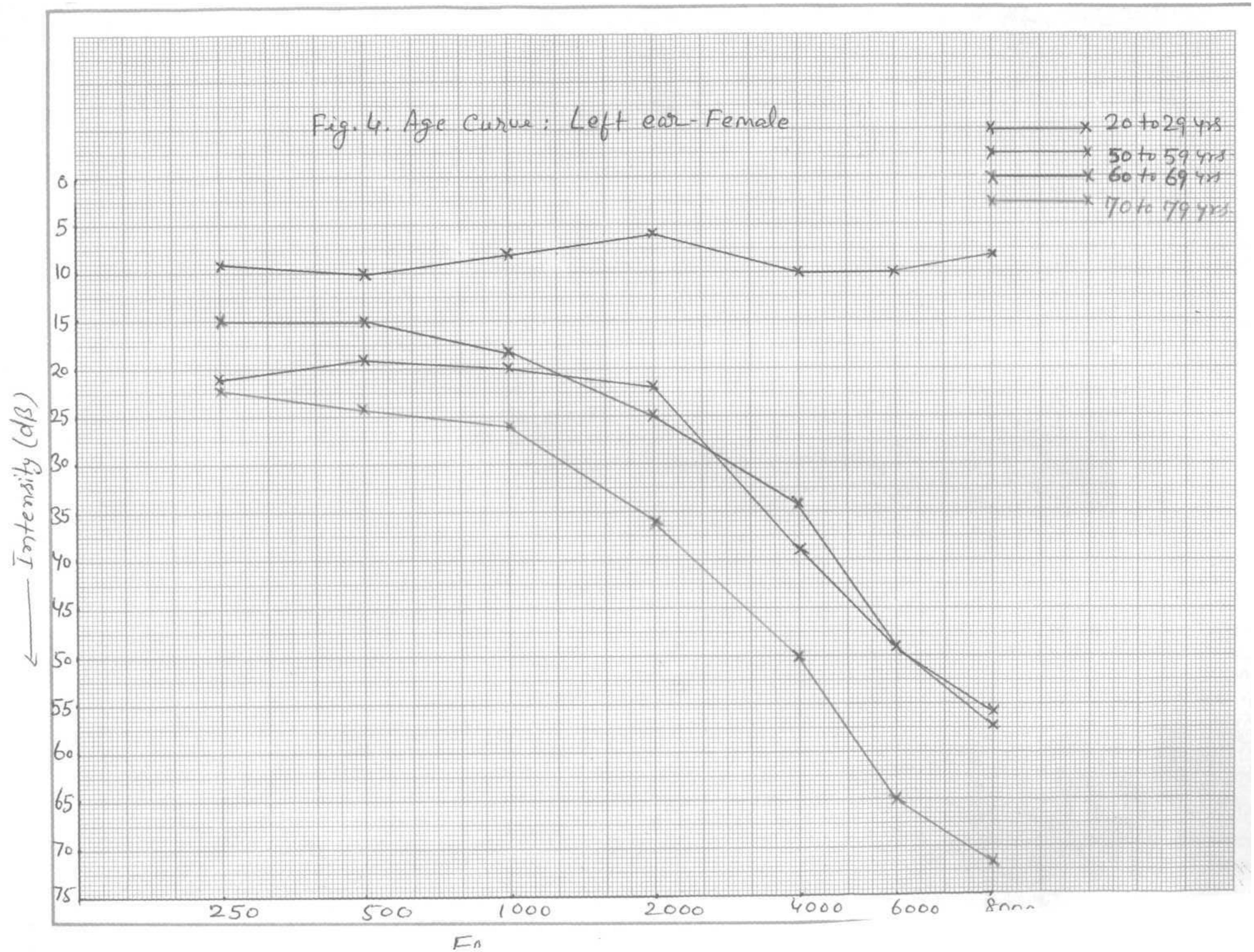


Fig. 3. Age Curve: Left ear - Male.
20 to 29 yrs
50 to 59 yrs
60 to 69 yrs
70 to 79 yrs
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
250
500
1000
2000
4000
6000
8000
Intensity (dB)
Frequency (Hz)

Fig. 4. Age Curve: Left ear - Female



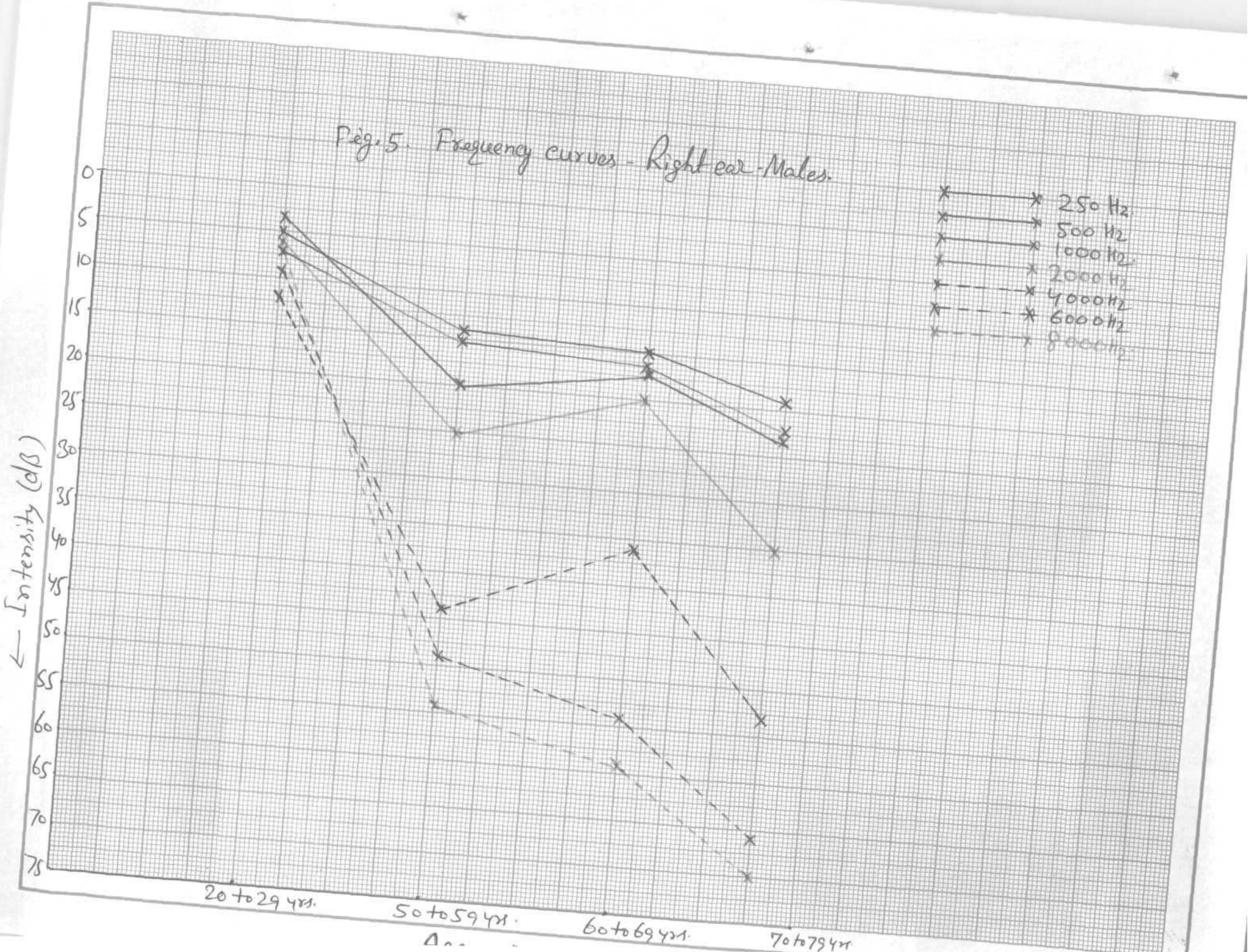


Fig. 5. Frequency curves - Right ear - Males.
250 Hz
500 Hz
1000 Hz
2000 Hz
4000 Hz
6000 Hz
8000 Hz
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
← Intensity (dB)
20 to 29 yrs.
50 to 59 yrs.
60 to 69 yrs.
70 to 79 yrs.

Fig-6. Frequency curve - Right ear-females.

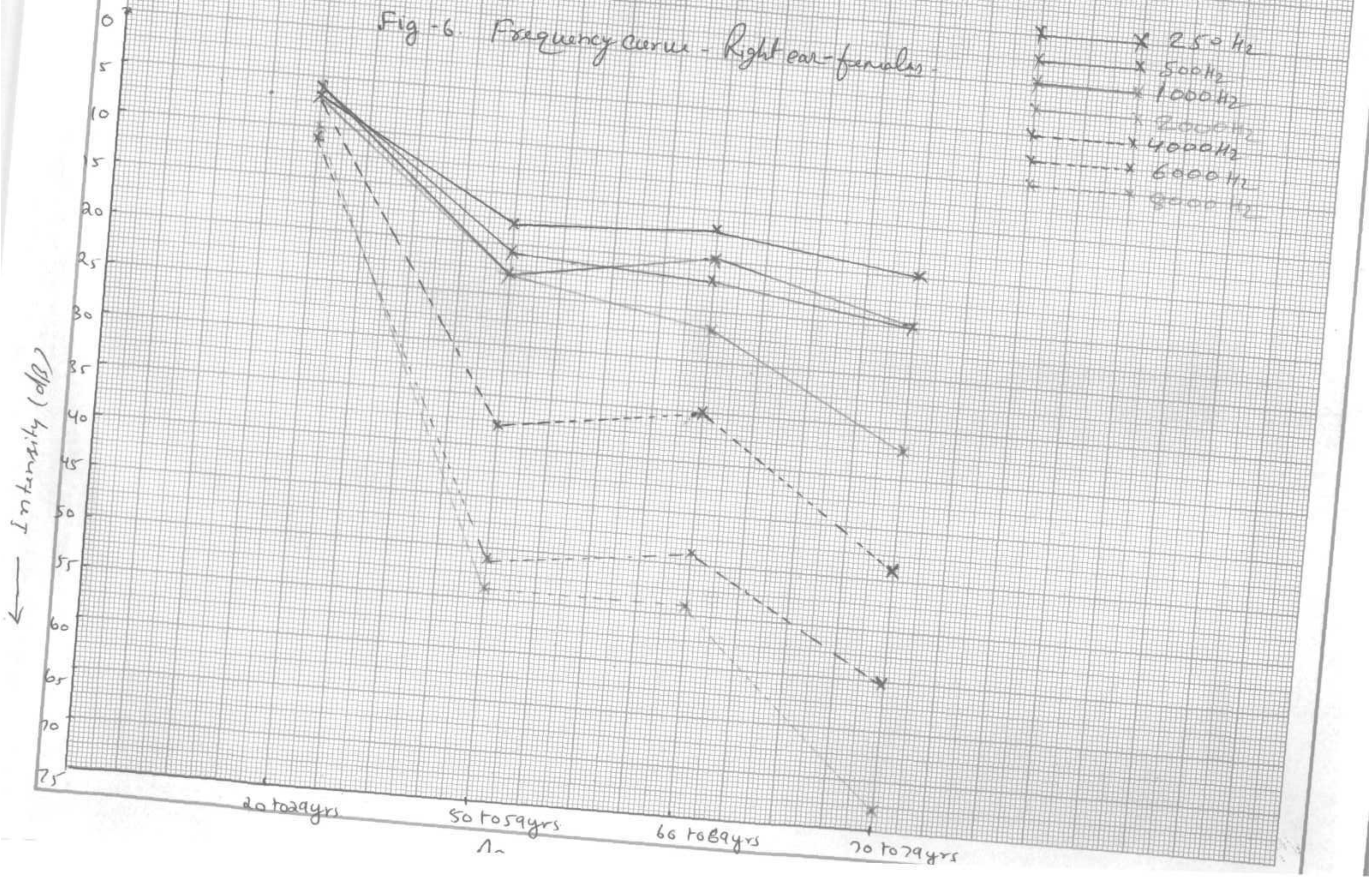


Fig. 7. Frequency curves - Left ear - Males.

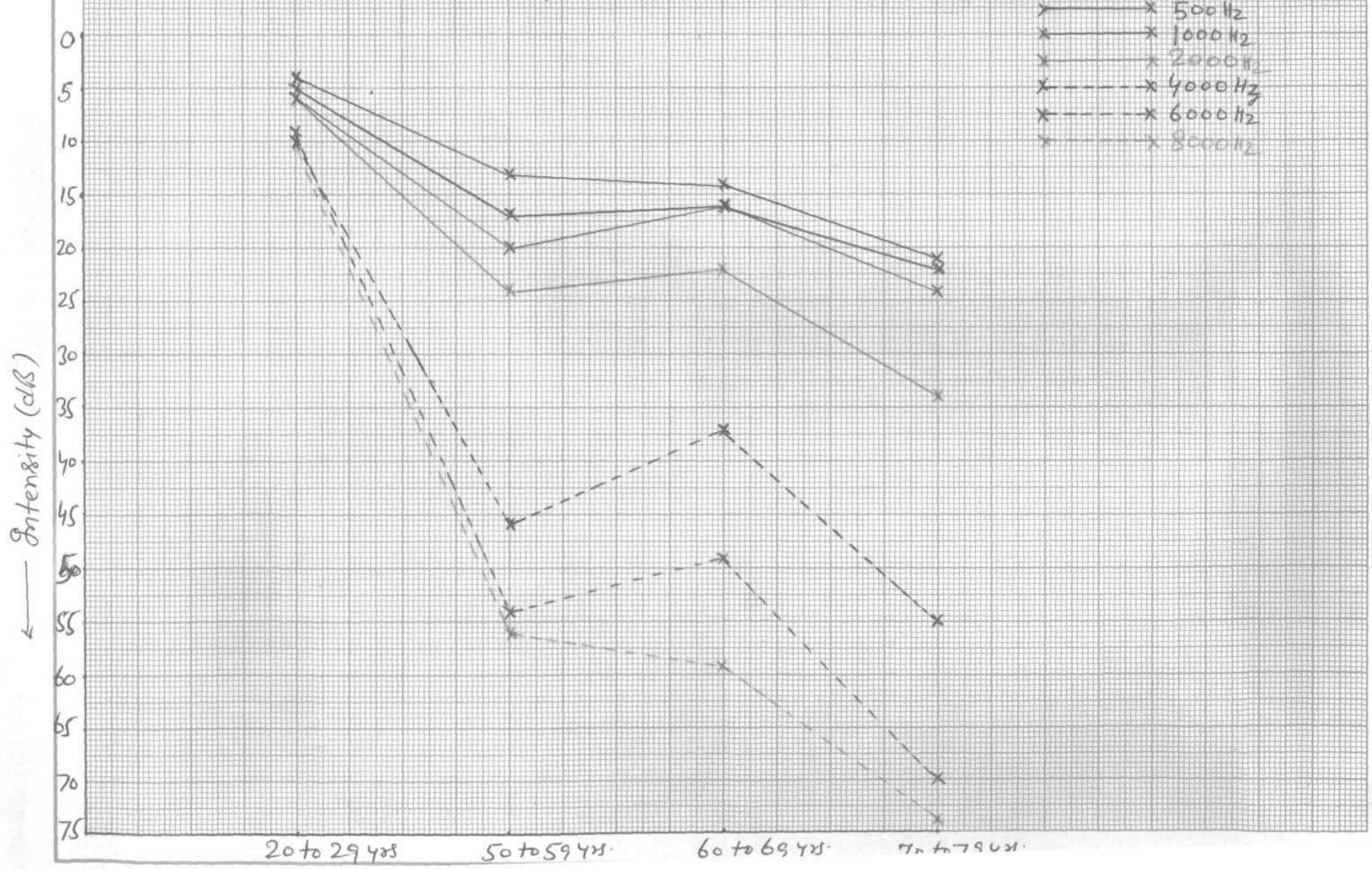


Fig. 8. Frequency curves-Left ear-Females

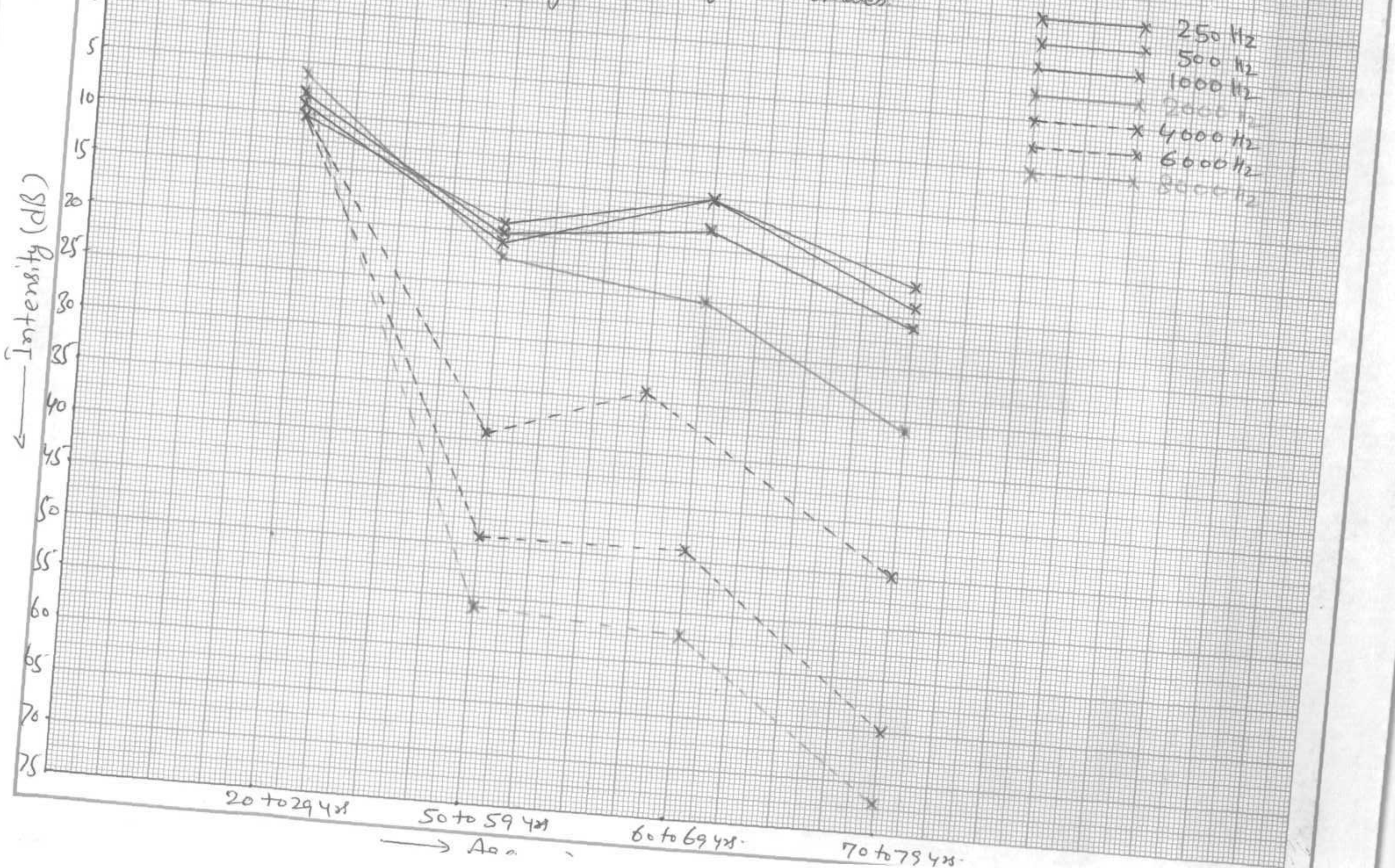


Table 1: Mean and Standard Deviation scores at 250 Hz, 500 Hz 1000 Hz, 2000 Hz, 4000 Hz, 6000 Hz and 8000 Hz for right ear of males of all age groups.

		20-29 Yrs. (A_1)	50-59 Yrs. (A_2)	60-69 Yrs. (A_3)	70-79 Yrs (A_4)
250 Hz	Mean	5	14	15	19
	SD	3.16	6.63	3.16	4.89
500 Hz	Mean	7	15	16	22
	SD	2.44	7.74	2.20	8.12
1000 Hz	Mean	4	20	17	23
	SD	2.00	7.74	2.44	7.48
2000 Hz	Mean	6	25	20	35
	SD	3.74	8.36	7.07	6.32
4000 Hz	Mean	12	44	36	53
	SD	2.44	15.93	5.83	10.77
6000 Hz	Mean	9	49	54	66
	SD	2.00	14.62	10.19	7.39
8000 Hz	Mean	7	54	59	70
	SD	2.44	13.56	10.19	8.36

Mean given in decibal (dB)
SD = Standard deviation

Table 2: Mean and Standard Deviation scores at 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz, 6000 Hz and 8000 Hz for right ear of female of all age groups.

		20-29 Yrs. (A_1)	50-59 Yrs. (A_2)	60-69 Yrs. (A_3)	70-79 Yrs. ((A_4)
250 Hz.	Mean	7	18	17	20
	SD	2.44	2.44	5.09	7.07
500 Hz.	Mean	6	21	22	25
	SD	3.74	5.83	5.09	4.47
1000 Hz	Mean	6	23	20	25
	SD	2.00	4.00	5.47	6.32
2000 Hz	Mean	7	23	27	37
	SD	4.00	4.00	8.71	4.00
4000 Hz	Mean	7	38	35	49
	SD	2.44	10.77	8.36	6.63
6000 Hz	Mean	11	51	49	65
	SD	2.00	9.16	8.60	5.47
8000 Hz	Mean	10	54	54	73
	SD	3.16	10.19	8.60	8.71

Mean given in decibal (dB)
SD = Standard deviation.

Table 3: Mean and Standard Deviation scores at 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz, 6000 Hz, 8000 Hz for left ear of male of all age groups.

		20-29 Yrs. (A_1)	50-59 Yrs. (A_2)	60-69 Yrs. (A_3)	70-79 Yrs. (A_4)
250 Hz	Mean	4	13	14	21
	SD	3.74	4.00	3.74	4.89
500 Hz	Mean	6	20	16	24
	SD	3.74	6.32	5.83	8.00
1000 Hz	Mean	5	17	16	22
	SD	4.47	8.12	3.74	6.78
2000 Hz	Mean	6	24	22	34
	SD	2.00	8.60	5.09	8.60
4000 Hz	Mean	10	46	37	55
	SD	3.16	7.34	9.27	9.48
6000 Hz	Mean	9	54	49	70
	SD	2.00	10.67	10.19	9.48
8000 Hz	Mean	10	56	58	74 (A_1)
	SD	3.16	11.57	9.27	.67

Mean given in decibal (dB)
SD = Standard Deviation.

Table 4: Mean and Standard Deviation scores at 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz, 6000 Hz, and 8000 Hz for left ear of female of all age groups.

		20-29 Yrs. (A_1)	50-59 Yrs. (A_2)	60-69 Yrs. (A_3)	70-79 Yrs. (A_4)
250 Hz	Mean	9	21	15	22
	SD	3.74	4.89	5.47	5.09
500 Hz	Mean	10	19	15	24
	SD	3.16	5.83	3.16	5.83
1000 Hz	Mean	8	20	18	26
	SD	2.44	4.47	6.78	3.74
2 000 Hz	Mean	6	22	25	36
	SD	2.00	5.09	9.48	5.83
4000 Hz	Mean	10	39	34	50
	SD	3.16	8.60	3.74	11.83
6000 Hz	Mean	10	49	49	65
	SD	3.16	6.63	11.13	4.47
8000 Hz	Mean	8	56	57	72
	SD	2.44	9.69	8.12	5.09

Mean given in decibal (dB)
SD = Standard Deviation.

Table 5: Showing the results of 't' scores for sex differences in right ear for pure tone threshold at 250Hz, 5 00 Hz, 1000 Hz, 2000 Hz, 4000 Hz, 6000 Hz and 8000 Hz of all the age groups between male and female.

	20-29 Yrs. (A_1)	50-59 Yrs. (A_2)	60-69 Yrs. (A_3)	70-79 Yrs. (A_4)
250 Hz.	1.00	1.13	0.66	0.23
500 Hz.	0.44	1.23	2.19	0.64
1000 Hz.	1.41	0.68	1.00	0.45
2000 Hz.	0.36	0.43	1.24	0.53
4000 Hz.	2.89*	0.62	0.19	0.63
6000 Hz.	1.41	0.34	0.74	0.21
8000 Hz.	1.50	0.00	1.11	0.49

* Significant at 0.5 level (2.31) for eight degree of freedom.

Table 6: Showing the results of 't' test scores for Age differences in right ear for males, for pure tone threshold at 290 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz, 6000 Hz, and 8000 Hz between the older age group (A_2,A_3, A_4) and younger age group (A).

	AGE GROUP		
	A_1 and A_2	A_1 and A_3	A_1 and A_4
250 Hz	2.45*	4.47**	3.13*
500 Hz	1.97	5.70**	3.53**
1000 Hz	4.00**	8.24**	4.90**
2000 Hz	4.14**	3.50**	7.87**
4000 Hz	3.97**	7.59**	7.42**
6000 Hz	5.41**	8.66**	14.32**
8000 Hz	6.82**	9.92**	14.46**

* Significant at 0.5 level (2.31) for eight degree of freedom.

** Significant at 0.01 level (3.36) for eight degree of freedom.

Table 7: Showing the results of 't' test scores for Age differences in right ear for females, for pure tone threshold at 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz, 6000 Hz, and 8000 Hz between the older age group (A_2, A_3 and A_4) and younger age group (A_1).

	AGE GROUP		
	A_1 and A_2	A_1 and A_3	A_1 and A_4
250 Hz	6.73**	3.54**	3.47**
500 Hz	4.33**	5.06**	6.51**
1000 Hz	7.59**	4.80**	5.73**
2000 Hz	5.65**	4.17**	10.60**
4000 Hz	5.63**	6.42**	11.82**
6000 Hz	8.53**	8.60**	18.53**
8000 Hz	8.24**	9.60**	13.59**

** Significant at 0.01 level (3.36) for eight degree of freedom.

Table 8: Showing Mean and Standard Deviation scores of ipsilateral and contralateral acoustic reflex thresholds at 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz for right ear of males of all the age groups.

			AGE GROUPS			
			20-29 Yrs. (A_1)	50-59 Yrs. (A_2)	60-69 Yrs. (A_3)	70-79 Yrs. (A_4)
IPSI-		Mean	94	99	95	98
	Hz	SD	4.89	6.63	4.47	7.48
	1000 Hz	Mean	92	98	104	103
		SD	4.00	7.48	4.89	6.00
	2000 Hz	Mean	96	106	110	104
		SD	4.59	5.83	5.47	4.89
	4000 Hz	Mean	Absent	A	A	A
		SD	-	-	-	-
CONTRA LATERAL ART	500 Hz	Mean	95	100	103	95
		SD	4.47	6.32	4.00	4.47
	1000 Hz	Mean	93	102	107	108
		SD	6.00	7.48	4.00	7.48
	2000 Hz	Mean	94	107	113	115
		SD	7.34	6.00	6.00	4.47
	4000 Hz	Mean	96	—	-	-
		SD	2.00	-	-	-

_ = Absent
Acoustic reflex threshold given decibals (dB) for pure tone.

Table 9: Showing Mean and Standard Deviation scores of ipsilateral and contralateral acoustic reflex thresholds at 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz for right ear of females of all the age groups.

			AGE GROUPS			
			20-29 Yrs. (A_1)	50-59 Yrs. (A_2)	60-69 Yrs. (A_3)	70-79 Yrs. (A_4)
Ipsi-lateral ART	500 Hz	Mean	95	98	95	101
		SD	4.47	2.44	4.47	5.83
	1000 Hz	Mean	98	100	102	105
		SD	4.00	5.47	4.00	6.32
	2000 Hz	Mean	98	106	107	109
		SD	4.00	3.74	6.00	3/74
	4000 Hz	Mean	-	--		-
		SD	-	--		-
Contra-lateral ART	500 Hz	Mean	96	103	103	101
		SD	4.89	4.00	4.00	4.89
	1000 Hz	Mean	97	107	104	110
		SD	6.00	4.00	4.89	10.98
	2000 Hz	Mean	100	115	114	-
		SD	3.16	4.47	3.74	-
	4000 Hz	Mean	99	--		-
		SD	2.00	--		-

\- = Absent
Acoustic reflex threshold given in decibals (dB) for pure tone.

Table 10: Showing Mean and Standard Deviation scores of ipsi-lateral and contralateral acoustic reflex thresholds 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz for left ear of males of all the age groups.

			AGE GROUPS			
			20-29 Yrs. (A_1)	50-59 Yrs. (A_2)	60-69 Yrs. (A_3)	70-79 Yrs. (A_4)
Ipsi-lateral ART	500 Hz	Mean	98	98	96	104
		SD	4.00	7.48	3.74	4.89
	1000 Hz	Mean	97	98	105	106
		SD	5.09	10.29	4.47	4.89
	2000 Hz	Mean	95	102	109	112
		SD	4.47	4.00	4.89	2.44
	4000 Hz.	Mean				
		SD				
Contra-lateral ART	500 Hz	Mean	97	102	100	108
		SD	6.00	4.00	3.16	4.00
	1000 Hz	Mean	97	101	104	110
		SD	4.00	8.00	4.89	6.32
	2000 Hz	Mean	95	105	112	118
		SD	6.32	8.94	7.48	4.00
	4000 Hz	Mean	98	-		-
		SD	5.09			

- = Absent

Acoustic reflex thresholds given in decibals (dB) for pure tone.

Table 11: Showing Mean and Standard deviation scores of ipsilateral and contralateral acoustic reflex thresholds at 500 Hz, 1000 Hz, 2000 Ha and 4000 Hz for left ear of females of all the age groups.

			AGE GROUPS			
			20-29 Yrs. (A_1)	50-59 Yrs. (A_2)	60459 Yrs. (A_3)	70-79 Yrs. (A_4)
Ipsilateral ART	500 Hz	Mean	97	99	101	102
		SD	4.00	2.00	2.00	6.78
	1000 Hz	Mean	99	104	103	109
		SD	4.89	4.89	4.00	4.89
	2000 Hz	Mean	99	104	110	113
		SD	2.00	8.00	6.32	2.44
	4000 Hz	Mean				-
		SD				
Contra-lateral ART	500 Hz	Mean	95	100	103	107
		SD	4.47	0.00	4.00	4.00
	1000 Hz	Mean	93	106	107	117
		SD	6.00	4.89	6.00	4.00
	2000 Hz	Mean	99	110	116	
		SD	4.89	8.36	4.89	
	4000 Hz	Mean	100		-	
		SD	3.16			

-= Absent

Acoustic reflex thresholds given in decibals (dB) for pure tone.

Table 12: showing the results of 't' score between male and female for sex differences in right ear for ipsilateral and contralateral acoustic reflex thresholds at 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz of 611 the age groups.

		AGE GROUPS			
		20-29 Yrs. (A_1)	50-59 Yrs. (A_2)	60-69 Yrs. (A_3)	70-79 Yrs. (A_4)
Ipsilateral ART	500 Hz	0.30	0.25		0.63
	1000 Hz	2.12	0.43	0.63	0.45
	2000 Hz	0.63	-	0.73	1.62
	4000 Hz	-	-	-	-
Contralateral ART	500 Hz	0.30	0.80		1.81
	1000 Hz	0.94	1.17	0.94	0.30
	2000 Hz	1.50	2.13	0.28	-
	4000 Hz	—	—	—	

- = Absent

Table 13: Showing results of 't' test scores for age differences in right ear of males for ipsilateral and contralateral reflex thresholds at 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz between the older age groups (50-59, 60-69, 70-79Yrs.) and younger age groups (20-29 Yrs.)

		A_1 and A_2	A_1 and A_2	A_1 and A_4
Ipsilateral Acoustic reflex thresholds	500 Hz	1.21	0.22	0.89
	1000 Hz	1.41	3.79**	3.05*
	2000 Hz	2.62*	3.81**	2.31*
	4000 Hz	-	-	
Contralateral Acoustic Reflex Thresholds	500 Hz	1.29	2.16*	
	1000 Hz	1.87	3.88**	3.14*
	2000 Hz	2.74*	4.00**	-
	4000 Hz	-	-	

* Significant at 0.5 level (2.31) for eight degree _ of freedom.

** Significant at 0.01 level (3.36) for eight degree of freedom.

Table 14: Showing results of 't' test scores for age differences in right ear of females for ipsilateral and contra lateral reflex thresholds at 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz, between the older age groups (50-59, 60-69 and 70-79 yrs) and younger age groups (20-29 Yrs.)

		A_1 & A_2	A_1 & A_3	A_1 & A_4
Ipsilateral ART	500 Hz	1.20		1.63
	1000 Hz	0.59	1.41	1.87
	2000 Hz	2.92*	2.49*	4.01**
	4000 Hz		-	-
Contralateral ART	500 Hz	2.21	2.21	1.44
	1000 Hz	2.77*	1.80	2.08
	2000 Hz	5.47**	5.72**	-
	4000 Hz			-

* Significant at 0.5 level (2.31) for eight degree of freedom

** Significant at 0.01 level (3.36) for eight degree of freedom.

Table 15: Showing mean and standard deviation score of static compliance(cc)of right and left ear for both male and female of all the age groups.

			AGE GROUPS			
			20-29 Yrs. (A_1)	50-59 Yrs. (A_2)	60-69 Yrs. (A_3)	70-79 Yrs. (A_4)
Right Ear	Male	Mean	0.95	0.87	0.72	0.67
		SD	0.18	0.13	0.16	0.42
	Female	Mean	1.04	0.82	0.76	0.72
		SD	0.19	0.24	0.18	0.29
Left Ear	Male	Mean	0.94	0.90	0.90	0.64
		SD	0.11	0.13	0.41	0.24
	Female	Mean	0.98	0.86	0.68	0.65
		SD	0.12	0.25	0.27	0.28

Table 16: Showing results of 't' score between male and female for sex differences in right ear and left ear for static compliance (c.c) of all the age groups.

	20-29 Yrs. (A_1)	50-59 Yrs. (A_2)	60-69 Yrs. (A_3)	70-79 Yrs. (A_4)
Right ear	0.68	0.36	0.33	0.19
Left ear	0.49	0.28	0.32	0.05

Table 17: Showing the results of 't' test score for age difference in right and left ear for both male and females for static compliance (c.c) between older age group (50-59, 60-69, 70-79 Years) and younger age group (20-29 Yrs.).

		A_1 and A_2	A_1 and A_3	A_1 and A_4
Right ear	Male	0.72	1.93	1.22
	Female	1.44	2.15	1.85
Left ear	Male	0.47	1.14	2.27
	Female	0.86	2.03	2.16

Table 18: Showing Mean and Standard Deviation scores of absolute peak latency(I, III, V), inter peak latency (I-III, III-V and I-V), and the amplitude of peak (I, V) for right ear of males of all the age groups.

			AGE GROUPS			
			20-29 Yrs. A_1	50-59 Yrs. A_2	60-69 Yrs. A_3	70-79 Yrs A_4
Absolute peak latency (ms)	I	Mean	1.54	1.70	1.70	1.86
		SD	0.05	0.10	0.05	0.12
	III	Mean	3.63	3.68	3.80	3.95
		SD	0.09	0.13	0.09	0.22
	V	Mean	5.51	5.73	5.76	5.90
		SD	0.13	0.16	0.18	0.31
Inter peak latency (ms)	I-III	Mean	2.09	1.97	2.09	2.09
		SD	0.11	0.14	0.05	0.11
	III_	Mean	1.88	2.05	1.94	1.94
		SD	0.15	0.11	0.26	0.32
	I-V	Mean	3.97	4.02	4.03	4.03
		SD	0.13	0.19	0.22	0.31
Amplitude /uV	I	Mean	0.22	0.08	0.11	0.04
		SD	0.02	0.02	0.01	0.01
	V	Mean	0.52	0.36	0.29	0.36
		SD	0.12	0.06	0.03	0.14

Table 19: Showing Mean and Standard Deviation scores of absolute peak latency (I, III, V), inter peak latency (I-III, III-V and I-V), and the amplitude of peak (I,V) for right ear of females of all the age groups.

			AGE GROUPS			
			20-29 Yrs. A_1	50-59 Yrs. A_2	60-69 Yrs. A_3	70-79 Yrs. A4
Absolute Peak latency (ms)	I	Mean	1.64	1.67	1.80	1.97
		SD	0.11	0.12	0.15	0.25
	III	Mean	3.53	3.79	3.84	3.74
		SD	0.10	0.18	0.16	0.15
	V	Mean	5.20	5.63	5.42	5.48
		SD	0.05	0.24	0.12	0.17
Inter peak latency (ms)	I-III	Mean	1.89	2.12	2.04	1.76
		SD	0.15	0.23	0.29	0.31
	III-V	Mean	1.66	1.84	1.65	1.74
		SD	0.07	0.25	0.24	0.05
	I-V	Mean	3.55	3.96	3.62	3.51
		SD	0.14	0.37	0.24	0.31
Amplitude (/uV)	I	Mean	0.23	0.21	0.10	0.10
		SD	0.03	0.16	0.04	0.05
	V	Mean	0.65	0.42	0.26	0.28
		SD	0.28	0.13	0.06	0.09

Table 20: Showing the Mean and Standard Deviation scores of absolute peak latency (I, III, V), inter peak latency (I-III, III-V and I-V) and the amplitude of peak (I,V) for r± left ear of males of all the age groups.

			AGE GROUPS			
			20-29 Yrs. A_1	50,59 Yrs. A_2	60-69 Yrs. A_3	70,79 Yrs. A_4
Absolute Peak latency (ms)	I	Mean	1.60	1.95	1.79	1.93
		SD	0.12	0.31	0.09	0.18
	III	Mean	3.59	4.07	3.76	3.99
		SD	0.06	0.36	0.15	0.24
	V	Mean	5.45	5.89	5.50	5.95
		SD	0.20	0.28	0.12	0.19
Interpeak latency (ms)	I-III	Mean	1.99	2.11	1.96	2.06
		SD	0.12	0.10	0.12	0.35
	III-V	Mean	1.85	1.82	1.74	1.96
		SD	0.14	0.19	0.26	0.13
	I-V	Mean	3.85	3.93	3.71	4.02
		SD	0.20	0.22	0.17	0.32
Amplitude (/uV)	I	Mean	0.27	0.08	0.16	0.07
		SD	0.07	0.02	0.05	0.02
	V	Mean	0.43	0.31	0.22	0.34
		SD	0.04	0.10	0.06	0.10

Table 21: Showed the Mean and Standard deviation scores of absolute peak latency (I, III, V), inter peak latency (I-III, III-V and I-V) and the amplitude of peak (I, V) for left ear of females of all the age groups.

			AGE GROUPS			
			20-29 Yrs. A_1	50-59 Yrs. A_2	60-69 Yrs. A_3	70-79 Yrs. A_4
Absolute peak latency (ms)	I	Mean	1.68	1.83	1.83	1.88
		SD	0.09	0.25	0.17	0.11
	III	Mean	3.74	3.68	3.56	3.86
		SD	0.17	0.15	0.08	0.06
	V	Mean	5.28	5.75	5.48	5.60
		SD	0.16	0.22	0.23	0.10
Interpeak latency (ms)	I-III	Mean	2.05	1.85	1.67	1.98
		SD	0.20	0.13	0.21	0.14
	III-V	Mean	1.53	2.06	1.99	1.73
		SD	0.13	0.17	0.18	0.08
	I-V	Mean	3.59	3.92	3.66	3.72
		SD	0.13	0.23	0.25	0.17
Amplitude	I	Mean	0.28	0.23	0.10	0.07
		SD	0.13	0.10	0.02	0.02
	V	Mean	0.55	0.46	0.25	0.40
		SD	0.12	0.08	0.07	0.12

Table 22: Showing obtained 't' values between male and female for sex differences for absolute peak latency (I, III, V) inter peak latency (I-III, III-V, I-V) and amplitude of peak (I-V) of right ear of all the age groups.

		AGE GROUPS			
		20-29 Yrs A_1	50-59 Yrs A_2	60-69 Yrs A_3	70-79 Yrs A_4
Absolute peak latency (ms)	I	1.65	0.38	1.27	0.79
	III	1.49	0.99	0.43	1.59
	V	4.47**	0.69	2.98*	2.37*
Interpeak latency (ms)	I-III	2.18	0.98	0.34	1.48
	III-V	2.65*	1.53	1.75	1.24
	I-V	4.47**	0.20	2.54*	1.91
Amplitude (/uV)	I	0.55	1.49	0.48	2.35*
	V	0.85	1.83	0.89	0.96

*Significant at 0.5 level (2.31) for eight degree of freedom.

**Significant at 0.01 level (3.36) for eight degree of freedom.

Table 23: Showing the 't' test values for age differences in right ear for male for absolute peak latency (I, III, V) inter peak latency (I-III, I-V and III-V) and amplitude of peak (I and V) between older age groups (50-59, 60-69 and 70-79 years) and younger age groups (20-29 years).

		A_1 and A_2	A_1 and A_3	A_1 and A_4
Absolute Peak latency (ms)	I	2.86	4.52**	4.93**
	III	1.78	2.71*	2.69*
	V	2.13	2.09	2.32*
Interpeak latency (ms)	I-III	1.37	0.00	0.00
	III-V	1.85	0.40	0.33
	I-V	0.43	0.74	0.35
Amplitude (/uV)	I	8.51**	9.83**	16.09**
	V	2.38*	3.80**	1.74

* Significant at 0.5 level (2.3l) for eight degree of freedom.

** Significant at 0.01 level (3.36) for eight degree of freedom.

Table 24: Showing the 't' test values for age differences in right ear for female for absolute peak latency (I, III, V) inter peak latency (I-III, I-V and III-V) and amplitude of peak (I and V) between older age groups (50-59, 60-69 and 80-79 years) and younger age groups (20-29 years).

		A_1 and A_2	A_1 and A_3	A_1 and A_4
Absolute peak latency (ms)	I	0.37	1.72	2.41*
	III	2.52*	3.29**	2.34*
	V	3.55**	3.39**	3.20*
Interpeak latency (ms)	I-III	1.49	0.91	0.75
	III-V	1.38	0.08	1.88
	I-V	2.22	0.50	0.23
Amplitude	I	0.24	5.28**	4.47**
	V	1.49	2.72*	2.54*

* Significant at 0.5 level (2.3l) for eight degree of freedom.

** Significant at 0.01 level (3.36) for eight degree of freedom.

SUMMARY AND CONCLUSION

The present investigation was undertaken to study the audiological test results in geriatric population (50-59, 60-69 and 70-79 years) and to compare the results with the younger age population (20-29 years). A sample of 40 subjects ranging in age from 20 years to 79 years were selected randomly from the general population. The sample was categorised into four age groups as follows. 20-29,yrs., 50-59 yrs., 60-69 yrs., and 70-79 yrs. Equal number of male and females was constant in each age groups.

A detailed case history was taken for each subject to rule out middle ear pathology, ototoxicity, and noise exposure, diabetes and other systemic diseases.

Air conduction pure tone audio-metric testing, impedance audiometric testing and brain stem evoked response audiometric testing was carried out for each subjects in sound treated room. The pure tone thresholds, static compliance, acoustic reflex thresholds, auditory brain stem response (I, III, V), inter peak latency (I-III, III-V, I-V) and amplitude of peak (I and V) were obtained. The data was presented in graphical and a tabular form. The results were analysed statistically.

CONCLUSIONS

The following conclusion can be drawn from the findings of the present study.

1. Significant changes occurs in hearing acuity as age advances.
2. The hearing threshold at higher frequencies was greatly affected than lower frequencies in the geriatric population.
3. Hearing thresholds are affected at higher frequencies for both males and females.
4. The hearing acuity changes in the right and the left ear is similar in geriatrics population.
5. Static compliance decreases as age advances. This change is common for both males and females.
6. A significant elevation in the acoustic reflex thresholds in the geriatric population is found.
7. No significant difference in acoustic reflex threshold among male and female was found.
8. An increase in latency for the different peaks (I, III and V) of auditory brain stem response takes place in geriatric population.
9. There is no significant difference in the interpeak latency value (I-III, III-V, I-V) in geriatrics was found.

10. The lower amplitude value for peaks I and peak V was observed in geriatric group compared to the younger groups.

SUGGESTIONS

1. The rate of progression of hearing loss as a function of age and sex may be studied.

2. Similar study may be carried out on a larger population.

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APPENDIX-A

CASE HISTORY

1. Name Date:
2. Age (Date of birth)
3. Sex
4. Education
5. Occupation Address:
6. Mother tongue

1) Do you suspect hearing impairment YES/NO

2) Medical History

   a. Consanguineous
   b. Hereditary disease
   c. Deafness in family
   d. Neurological disorder
   e. Systemic disease
   f. Drugs taken (Specify)
   g. Physical & Emotional trauma
   h. Erruptic fever
   i. Allergic condition
   j. Head injury (unconciousness/convulsions)
   k. Ear infection and hearing problem
   1. Congenital Anomalies

m. Recurrent respiratory infection

n. Surgical treatment

o. Measles, chicken pox, Meningitis, Jaundies, Encephalitis, Epilepsy, Dysorthyis.

3) Speech and language development History YES/NO

4)

4) Discovery of the hearing problem

a) Age at which the defect was first noticed.

b) Present status

c) Any medical treatment given.

APPENDIX-B

HEAPING MEASUREMENT SCALE

The following questionnaire is designed to evaluate your communication ability as you view it. You have to judge the each statement given below,

INTENSITY

1. Do you feel you have difficulty in hearing? YES/NO
2. Do you understand better when people talk loudly? YES/NO
3. Do you feel that people speak too softly? YES/NO
4. Do your family member react to you when you increase the volume of TV/Radio? YES/NO

FREQUENCY

1. Do you understand better when speaker is male? YES/NO
2. Do you understand better when the speaker is female? YES/NO
3. Do you find difficulty while"talking on telephone? YES/NO

RATE

1. Do you think people speak too fast? YES/NO
   and Do you have difficulty in
2. understanding their speech?

2. Do you ask people to speak slower? YES/NO
3. Do you ask them to speak loudly when you are not able to understand? YES/NO
4. Do you ask your family member around you to help when you don't understand the other speech? YES/NO

ENVIRONMENT

1. Do you ever have difficulty hearing in conversation when you are talking with one person?
   - at home? YES/NO
   - at outside? YES/HO
2. Do you find difficulty in conversing with one person face to face in quite room? YES/NO
3. Do you ever have difficulty in group conversation ?
   - at home YES/NO
   - at outside YES/NO
   - at work YES/NO
4. Do you have difficulty hearing the speaker at a public gathering/meeting? YES/NO
5. Do you find difficulty in conversing with persons when radio/TV is on? YES/NO
6. Do you find difficulty in conversing while travelling on a bus/car/aeroplane ? YES/NO

Non-Speech Sound

1. Can you hear when some one rings the door bell or knocks the door ? YES/NO
2. Can you hear you pets barks? YES/NO
3. Can you hear car/motor home in the street? YES/NO

LOCALIZATION

1, Do you turn your head the wrong direction when some one calls to you ? YES/NO
2. Are you able to tell the direction of sound when you hear a sound ? YES/NO

REACTION TO HANDICAPPED

1. Do you think you are irritable than others? YES/NO

2. Do you ever bothered or upset if you are unable to follow conversation? . YES/NO

3. Do you ever get the feeling of being cut off from things because of difficulty in hearing ? YES/NO

TINNITUS

1. Do you ever get a noise in your ear or in your head ?
   a) Does it present continuously/ intermittently ? YES/NO
   b) Does the tinnitus disturb in sleeping? YES/NO

EVALUATION

1. Have you under gone for audiological testing/examination ? YES/NO

2. Have you been advised to use a hearing aid? YES/NO

3. Have you been using a hearing aid ? YES/NO
   since how long?

PERSONAL OPINION

1. Do you think your hearing is normal? YES/NO

2. Do you think you don't have problem in conversation? YES/NO

3. Do you think any difficulty in hearing is serious? YES/NO

4. Does the difficulty of hearing - restrict your social and personal life? YES/NO

APPENDIX-C

CALIBRATION PROCEDURE

Pure-Tone calibration

The intensity and frequency calibration of the pure tone generated by the audiometer (Madsen OB 822 Clinical audiometer) was carried out.

Intensity Calibration

The intensity calibration was done with the audiometer output set at 70 dB HL. The acoustic output of the audiometer was fed through ear phones (TDH 39 with MX 41/AR ear cussions) condensor microphones (B&K 4144), which was coupled to an artificial ear (B&K 4152). The microphones was connected to a B&K preamplifier type 2616. Then the signal was fed into a sound level meter (B&K, 2209). The output sound pressure level at all the frequencies (250 Hz to 8000 Hz at octave level) was measured. When there was a difference of more than 2.5 dB from the specified output, the audiometer was internally caliberated to meet the ANSI (1969) standards. Internal caliberation was done by adjusting the presets. Thus the output level did not differ by more than 2.5 dB from the specified AMSI standards.

For checking he linearity of the attenuator, the some set up as for intensity caliberation was used. Here at 500 Hz,1000 Hz, and 4000 Hz, the attenuater dial reading was increased in 5dB steps and the concomitant SPL reading were noted.

Frequency calibration

Frequency calibration of the audiometer was done using a frequency counter (Rodart 203). The output of the audiometer was fed to the frequency counter maintaining the intensity at a constant level, the frequencies were sweeped from 250 Hz through 8000 Hz. The corresponding digital read out for each frequency was noted. The frequency of the tone generated by the audiometer was found to be within the permissible 3% variation from the dial reading.

APPENDIX-D

The ambient noise in the test room was measured using a sound level meter (B&K 2209) with an half an inch condenser microphone (B&K 4165) and Octave filter set (B&K 1613). The noise level in the test room at each octave frequency has been given in table below.

Octave frequencies in Hz	SPL values inside the test toom Ref: 0.0002 dy/cm^2
250	21
500	12
1000	10
2000	08
4000	10
6000	10
8000	10

APPENDIX-E

AUDIOGRAM

CASE NO. Date of Evaluation:

		FREQUENCY IN Hz					
		250	500	1000	2000	4000	6000
Air conduction	Right						
	Left						
Bone conduction	Right						
	Left						
Other Tests							
Diagnosis	Right						
	Left						

SIGNATURE

APPENDIX-F

IMPEDENCE AUDIOMETER

Case No. Date of Evaluation:

Name: Age: Sex:

Tympanogram: Right Left

Static compliance: Right Left

Acoustic reflex thresholds	500Hz	l000Hz	2000Hz	4000Hz
Ipsilateral				
Right:				
Left:				
Contralateral				
Right:				
Left:				