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Adverse Effects of Extended high frequency Hearing Impairment on Digit in Noise Perception

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Purpose: The present study aims at comparing the adverse effects of EHF hearing loss with Digit In Noise perception, between two age groups-Young adults and Early adulthood.

Methods: A total of 30 participants aged between 18 to 25 years as Young adults group and 26 to 35 years as early adulthood group were included in the study. All the participants were having EHF hearing loss with normal conventional audiogram. Digit in Noise test was carried out for these subjects. Digit in Noise recognition threshold was considered here.

Results: When compared to young adults group, the early adulthood population exhibited poorer thresholds at EHFs as well as 95% of the participants in this group showed poor scores in DIN test. Among the young adults group, 46.6% showed poor DIN scores.

Conclusions: Poor DIN recognition thresholds along with EHF loss despite normal conventional audiogram results necessitate the inclusion of EHF audiometry and Speech in noise test as part of the routine audiological evaluations. This helps in early detection, monitoring and prevention of hearing loss even during the third decade of human life.

Keywords: Extended high frequency, Digit in noise, Speech in noise, Speech perception

INTRODUCTION

The healthy, young human auditory system can detect tones in quiet with frequencies ranging from approximately 20 Hz to 20,000 Hz. This standardized range is identified using the classic methods of estimating minimal audible levels called Minimal Audible Pressure and Minimal Audible Field Measures. It has also been identified from these methods that human auditory system is very sensitive for the sounds ranging from 2,000 Hz to 5,000 Hz due to ear canal resonance effects. But when it comes to the routine hearing assessment to identify the presence of hearing loss the frequency range is shortened from 250 Hz to 8,000 Hz as the standard frequencies for Pure tone Audiometry testing. The major reason behind this is the presence of speech banana in which the speech sounds or phonemes of all the known human languages are plotted [1].

Audiologists are primarily concerned with hearing loss that occurs within the speech banana because it can slow the development of a child's language and speech abilities, and this in turn can profoundly interfere with learning. Hearing loss within the speech banana can also hinder communication capabilities in adults especially in the presence of back ground noise and/or conversation in a group. This condition gets wors-

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ened further as the age increases.

There are recent research evidences shows that the aforementioned difficulties may occur even when the subject obtains a normal audiogram result between 250 Hz to 8,000 Hz. This led to the extension of hearing assessment to further higher frequencies from 8,000 Hz to 20,000 Hz which is called as Extended High frequency audiometry. The hearing loss seen at these frequencies is defined as Extended high frequency hearing impairment or Hidden Hearing loss since it cannot be detected using the conventional audiogram [2].

EHF hearing impairment is often considered as an early sign of aging, noise damage, ototoxicity, and other factors [3]. Some other evidence also suggests that listeners with difficulty understanding speech-in-background noise may have poor EHF thresholds despite a normal audiogram [4].

AIM

The present study is aimed at comparing the adverse effects of extended high frequency hearing loss despite having a normal conventional audiogram on Digit In Noise perception between young adults and early adulthood.

METHODS

The present study was carried out in Dpt. Of Audiology, MAA Institute of Speech and Hearing, Hyderabad. A total of 30 participants were included in the study. They were categorized into two groups based on the age.

Group 1: Young adults

A total of 15 students aged between 18 to 25 years were included in this group with Extended High Frequency hearing impairment, which is considered as thresholds obtained at any of the following frequencies in any ear is 20 dB HL or above-10 kHz, 12.5 kHz, 14 kHz, and 16 kHz despite having a normal routine audiogram (thresholds at every frequency is within 15 dB HL). They were identified during routine biological calibration of instruments/daily listening checks. None of them were having any co morbid conditions and no complaints regarding reduced hearing sensitivity.

Group 2: Early adulthood

A total of 15 participants aged between 26 to 35 years were selected with Extended High Frequency hearing impairment, which is considered as thresholds obtained at any of the following frequencies in any ear is 20 dB HL or above -10 kHz, 12.5 kHz, 14 kHz, and 16 kHz despite having a normal routine audiogram (thresholds at every frequency is within 15 dB HL). They were identified as part of the In house staffs hearing assessment camp conducted in the Department of Audiology, MAA ENT Hospitals/MAA Institute of Speech and Hearing. None of the participants were reported having any co morbid conditions. Few of the participants reported difficulty in speech perception with the presence of background noise occasionally.

The EHF audiometry testing was carried out in a soundproof room using a clinical audiometer (Maico MA 42–Dual channel digital audiometer) and Senheiser HDA 2,000 Circum aural earphones. The air-conduction hearing thresholds at 10 KHz, 12.5 KHz, 14 KHz, 16 KHz were detected for Right ear and Left ear separately using Modified Hughson–Westlake method and plotted on a high frequency audiogram and conventional hearing thresholds were plotted on the standard audiogram.

Followed by this, Digit In Noise recognition test was carried out via a customized version of Angel Sound software (v5.08.03, Emily Shannon Fu Foundation, Los Angeles, CA). Stimuli used for the testing was software generated single digits ‘0’ through ‘9’ pre recorded by a male speaker in the presence of multi talker babble. Multi-talker babble was used as the background noise because it is considered the most commonly occurring noise that interferes with speech communication [5].

For each presentation, three digits were randomly presented in sequence (e.g., “3-5-8”) along with multi talker babble which was delivered mono aurally via HDA 300 headphones at 65 dB SPL. Participants were instructed to listen to the stimulus and click on to the response boxes labelled “0” through “9” on the laptop screen depends on the digits they recognized. A correct response for an entire sequence in digit-triplets reduced the SNR by 2 dB, while the SNR was increased by 2 dB if at least one number in the digit-triplet was not correctly identified. This was automatically driven by the software. Each test run consisted of 25 trials. Digit In Noise recognition threshold was defined as the SNR needed to produce 50% correct recognition of a three-digit sequence. Recognition thresholds were obtained for both ears. Each participant received two familiarization trials before the actual testing.

Statistical analysis done using ‘Fischer’s extract test and Wilson brown test’ to find out the level of significance between Group 1 and Group 2 in terms of Digit in Noise recognition thresholds.

RESULTS

All the participants included in the study were having extended high frequency impairment in atleast one frequency among 10 KHz, 12.5 KHz, 14 KHz, 16 KHz either in one ear or in both ears. When compared to young adults (Group 1), participants in the early adulthood (Group 2) were having poorer thresholds at extended high frequencies. Among this 12.5 kHz to 16 kHz were affected the maximum.

Even though, participants included in the young adults were not having any complaints regarding difficulties in perception of speech with the presence of background noise, 46.6% of the participants in Group 1 showed poor Digit in Noise recognition thresholds. When we consider Group 2, more than 95% of the total participants exhibited poor digit in noise recognition thresholds (Figure 1). This result was correlating with their concern about difficulty in speech perception with the presence of back ground noise. Table 1 shows the statistical analysis results.

The results showed no significant difference in digit in noise recognition thresholds between Group 1 and Group 2.

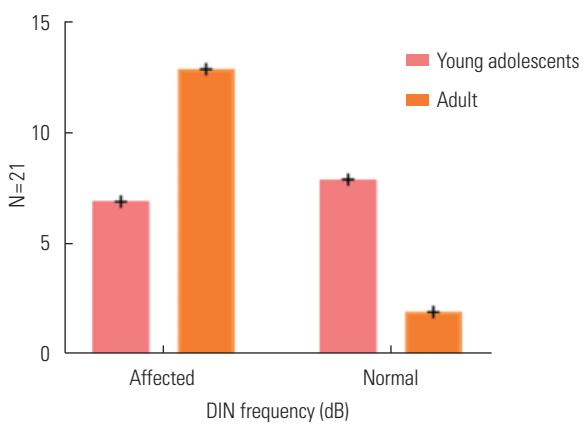

Figure 1. A Fischer extract test analysis shows the sensitivity and specificity between two groups along with level of significance exists among them in DIN scores.

DISCUSSION

Results of the study shows poor digit in noise recognition thresholds for majority of the total number of participants included in the study despite having a normal conventional audiogram. Literatures named this condition as Obscure auditory dysfunction. The other major finding of this study shows no significant effect of aging in both extended high frequency hearing impairment and digit in noise recognition thresholds ($p=0.02$ for both the groups). Traditional thoughts about the aging process starts from fourth decades of human life. Whereas results of the present study alert us that process of aging may start even during early third decade of life.

Ototoxicity, Noise induced hearing loss, Head trauma, Genetic issues etc were given primary importance when one considers the risk factors of EHF hearing impairment especially in young adults as well as early adulthood. Results of this study is contradicting these factors by showing the chances of having signs of early aging. Results in digit in noise recognition thresholds for young adults (Group 1) also recommends to assess the adverse effects of over use of earphones on extended high frequency thresholds and digit in noise recognition thresholds.

CONCLUSION

Poor digit in noise recognition thresholds in association with extended high frequency hearing impairment despite having a normal conventional audiogram in young adults as well as early adulthood population necessitates the mandatory inclusion of EHF audiometry and Speech in noise testing along with routine pure tone audiometry test. Which helps in early detection, monitoring, prevention and introduction of early rehabilitation measure if needed even for young adults. The results also demand more research activities to better understand the physiology behind Hidden Hearing loss and its adverse effects on daily communication.

Table 1. A Fischer extract test analysis shows the sensitivity and specificity between two groups along with level of significance exists among them in DIN scores

Age	Groups	DIN range	Affected		Normal		Fischer's extract test and wilson brown test		
			N	N%	N	N%	sensitivity	specificity	Level of significance
18-25 years	Young adolescents	-10 to -14 dB	7	23	8	26	0.48	0.18	$p=0.02$
26 to 35 years	Adult	-10 to -14 dB	13	43	02	7	0.48	0.18	$p=0.02$

**$p<0.05$ is considered as level of significance.

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