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ORIGINAL ARTICLE

EFFECT OF USAGE OF PERSONAL MUSIC PLAYERS ON HEARING IN STUDENTS AGED 18-25 YRS

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ABSTRACT: PURPOSE: Personal music players are important part of our lives as a recreational tool. Teenagers use and then abuse the technology, but due to lack of adequate knowledge about the harmful effects, this population is under risk for early sensorineural hearing loss and morbidity. We, therefore, investigated the effects, the relationship between music players, usage patterns and outcome in our study population. **MATERIALS AND METHODS:** A total of 104 MBBS students were interviewed personally regarding their use of portable music players, including the time and type of player and the type of headphone used. Pure tone audiometry was performed in each subject. **RESULTS:** Out of 104 students, 13 (12.6%) were found to be having sensorineural hearing loss with volume settings directly correlating with degree of hearing loss. **CONCLUSION:** Use of music players has a direct relationship with prevalence of sensorineural hearing loss among the subject population. To prevent permanent effects, the duration and intensity of sound should be at minimum

KEYWORDS: Personal music players, hearing loss, socioacusis, head phones, earphones, mp3 players, Temporary threshold shift (TTS), permanent threshold shift (PTS), noise-induced hearing loss (NIHL), sensorineural hearing loss (SNHL).

INTRODUCTION: Environmental noise is a common and preventable cause of hearing loss in industrialized societies. Socioacusis is the term used for hearing loss that is caused by the noise exposure due to recreational or non-occupational activities and listening to music is one of the most common forms of recreational noise exposure.

Effects to noise exposure could have auditory effects like auditory fatigue, tinnitus, hearing loss and non-auditory effects like psychological (annoyance) and physiological changes (increase in HR, BP). The effects may be in the form of temporary threshold shift (TTS) lasting up to few hours or permanent threshold shift, i.e., when temporary threshold shift does not recover completely.

The damage caused by noise depends on the frequency, intensity and duration of noise. Overstimulation of the hair cells leads to increased production of reactive oxygen radicals, leading to oxidative cell death. Both inner and outer hair cells are affected but outer hair cells are more susceptible, starting from basal turn of cochlea.

We know that usage of personal music players has been a trend among youngsters these days. Acquired Sensorineural hearing loss is among the leading preventable causes of hearing loss and there is an unmet need for more education regarding the risks of loud music exposure. There is no reporting system in place for incidence of hearing loss in India. Our study aims to create awareness about socioacusis and its prevention.

Only a few reports from India give statistical data regarding the incidence and etiology of hearing impairment. Indian Council of Medical Research (ICMR) report in 1983 found the proportion of hearing impairment to be 10.7%.

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REVIEW OF LITERATURE

- A daily exposure of 85 dB(A) for 8 hrs is about the limit people can tolerate without substantial damage to hearing.[1]
- Previous investigators have demonstrated that maximum output Levels from headphones can exceed safe levels. Free-field equivalent sound pressure levels measured at maximum volume control setting ranged from 91 dBA to 121 dBA. Output levels varied across manufacturers and style of headphone, although generally the smaller the headphone, the higher the sound level for a given volume control setting. In a few headphone-CD player combinations, peak sound pressure levels exceeded 130 dB SPL.[2]
- Based on measured free-field equivalent sound levels from PLD headphones and the reported PLD use, per day 58.2% of participants exceeded 85 dB A-weighted 8-hr equivalent sound levels (L(Aeq)), and per week 51.9% exceeded 85 dB.[3]
- Maximum permissible time limit for various sound intensities.[4]

Duration per day	Sound level, dB(A)
Hours	
24	80
16	82
8	85
4	88
2	91
1	94
Minutes	
30	97
15	100
7.50*	103
3.75*	106
1.88*	109
0.94*	112

- A study indicated that most of the participants reported high or very high volume settings and demonstrated low awareness towards loud music listening consequences. Physical measurements corrected for diffuse field indicated mean preferred listening levels of: 82 (SD = 9) dBA in quiet, and 89 (SD = 9) dBA in the presence of background noise.[5]
- Although preferred listening levels in quiet environments may be at acceptable levels, the addition of background noise will add to the overall noise exposure of a listener.[6]
- A study reported Personal music players to have a deleterious effect on hearing threshold. Significant elevations of hearing threshold were observed in males, in adolescents who had used portable music players for over 5 years, for those over 15 years in cumulative period and in those who had used earphones.[7]

- In a study the results for the exposure conditions explored indicate that changes in otoacoustic emissions may precede the development of music-induced hearing threshold shifts.[8]
- In a study, majority of listeners wore MP3 players for less than 2 hr daily at safe volume levels. About one third of respondents reported being distracted while wearing an MP3 player, and more than one third of listeners experienced soreness in their ears after a listening session. About one third of respondents reported occasionally using their MP3 players at maximum volume levels. Listeners indicated willingness to (a) reduce volume levels, (b) decrease listening duration, and (c) buy specialized earphones to conserve their hearing.[9]
- According to a study, most college students were knowledgeable about hearing health but could use information about signs of and how to prevent hearing loss.[10]
- The output levels of PLDs are capable of reaching levels that could increase the risk for MIHL, and 14% of teenagers in a study reported behaviour that puts them at increased risk for hearing loss. However, measured listening levels in the laboratory settings did not correlate well with self-reported typical listening levels.[11]

OBJECTIVE OF STUDY: To assess the relationship between use of personal music players and hearing loss among young listeners.

MATERIAL AND METHOD OF STUDY: SOURCE OF STUDY: Pure tone audiometry samples of MBBS students between the age group of 18-25years in our college.

METHOD OF STUDY:
TYPE OF STUDY: cross-sectional study.

SAMPLE SIZE: 104.

RATIONALE FOR SAMPLE SIZE: Based on the literature reference, a study conducted by Colin Mathers, Andrew Smith and Marisol Concha titled "global burden of hearing loss in the year 2000" it was found that 11.5% of the individuals in the age group of 15-25 had noise induced hearing loss[12]. So with absolute precision of 6% and the desired confidence level of 95% the sample size for the present study was 104.

PERIOD OF STUDY: Two months.

INCLUSION CRITERIA: Students between the age group of 18-25 who listen to personal music players.

EXCLUSION CRITERIA: Individuals who have had a prior exposure to/are now exposed to significant noise (exposure to continuous, intermittent, or impact noise in excess of a peak C-weighted level of 140 dB - explosions, gunfire and firecrackers[13]). Individuals with other causes leading to hearing loss like acute and chronic suppurative otitis media, traumatic perforation of tympanic membrane, serous otitis media, Eustachian tube block and congenital hearing loss.

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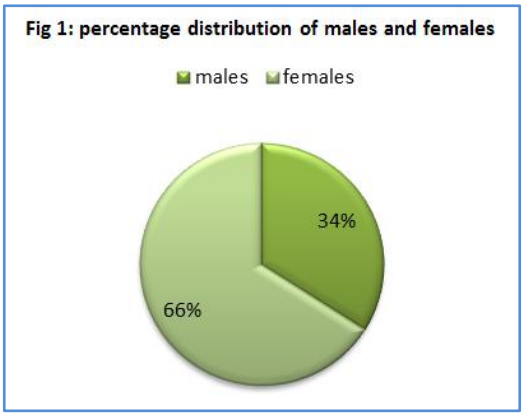
METHODOLOGY: After an informed consent from the individuals selected randomly, a questionnaire pertaining to the details required for the study was given. Ear examination was done to detect abnormalities/pathologies, if any, in the external auditory canal (impacted wax, otitis externa) or tympanic membrane (perforation). Pure tone audiometry was conducted on the individuals and the results noted. The hearing level threshold according to age will be compared with normal levels (0-25 dB) and its relation to daily usage time, usage period, listening method, type of music was analyzed. Volume levels were assessed using visual analogue scale.

PURE TONE AUDIOMETRY: Hearing thresholds at the frequencies of 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz, and 8000 Hz are determined. Minimum hearing threshold is measured by modified Huxon Wesley method- An initial tone of 60dB is given following which tone levels are reduced in 10-dB steps until no further response occurs. Increase the level of the tone in 5-dB steps until a response occurs. Threshold is the minimum intensity level at which an individual can hear at least 50% of the time. Also different transducers namely headphone and bone vibrator will be used to check for air conduction and bone conduction respectively.

STATISTICAL ANALYSIS: All the quantitative variables like age, hearing threshold etc. will be expressed in terms of mean and standard deviation. All qualitative variables such as gender, type of personal music player etc. will be expressed in terms of proportions. The prevalence of hearing loss among students was computed. The association between hearing loss and duration of usage, volume, type of transducer was compared using chi-square test of significance. P value≤0.05 was considered as statistically significant. SPSS version 17 was used to analyze the data.

OBSERVATION AND RESULT:

- Of the 104 students subjected to audiometry, one was excluded as he had conductive hearing loss.
- Of the 103, 68(66%) of the subjects were females and 35(34%) were males aged between 18 - 25 years, the mean age being 20.14 ± 1.27 (Mean ±SD).



- 75(72.8%) subjects used earphones only, 3 (2.9%) used headphones only, 4 (3.8%) used speakers only, 4(3.8%) used both headphones and earphones, 12(11.6%) used both earphones and speakers, 2 (1.9%) used both headphone and speakers and 3(2.9%) used all three of them.

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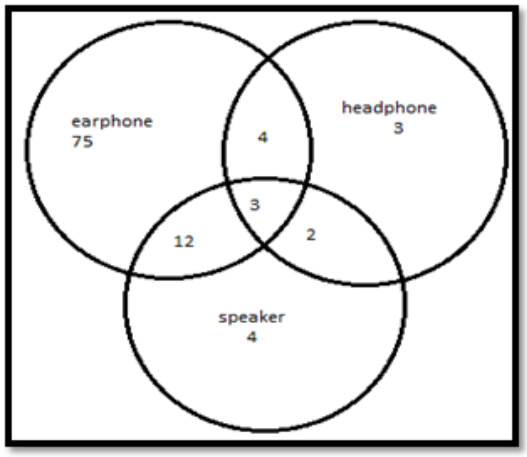
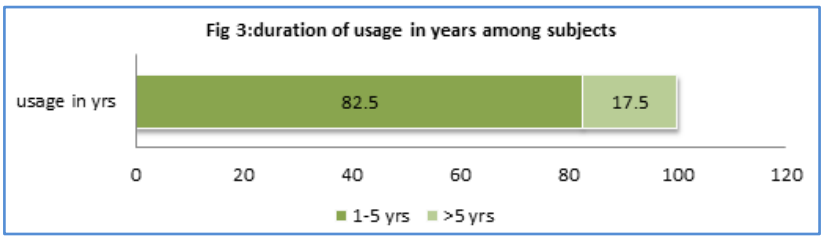
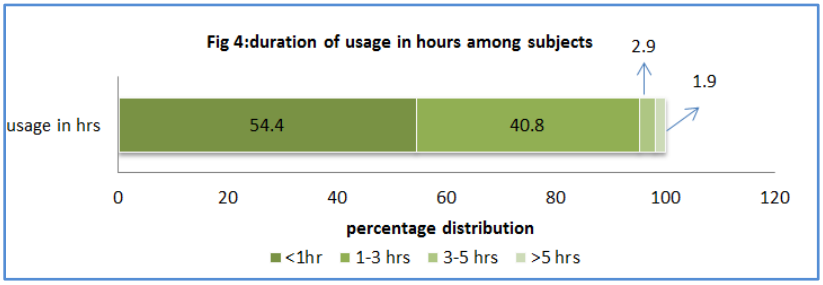


Fig 2: Venn diagram showing usage pattern of transducers.

- The overall usage period of personal music players was 1-5 years in 85(82.5%) subjects and more than 5 years in 18(17.5%). The median duration of usage in years was 3(2-5) [Median (IQR)].



- 56(54.4%) subjects used personal music players for less than 1 hour per day, 42(40.8%) subjects used for 1-3 hours per day, 3 (2.9%) used for 3-5 hours per day and 2(1.9%) used for more than 5 hours per day. The median duration of usage every day in hours was 1(1-2) [Median (IQR] (p=0.03). 98(95.1%) subjects used less than 3 hours and 5(4.9%) subjects used more than 3 hours.



- Of the 103 subjects, 40 subjects listened to soft music only, 25 listened to rock music only, 2 listened to classical and 6 listened to metallic only.19 listened to both soft and rock, 8 listened to both soft and classical, 3 listened to both rock and classical and the rest listened to all 4 types of music.

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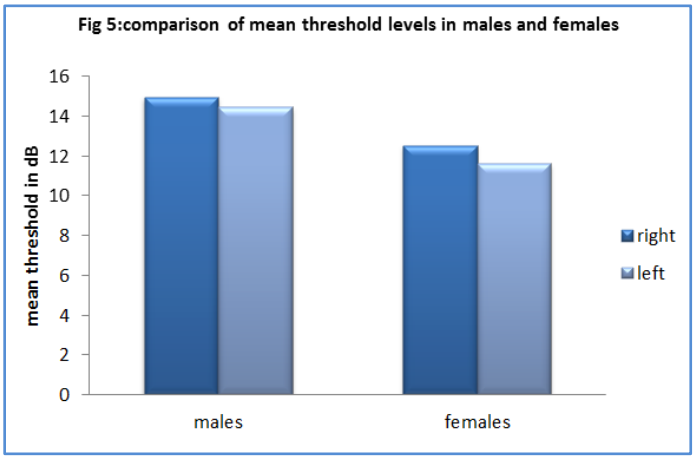
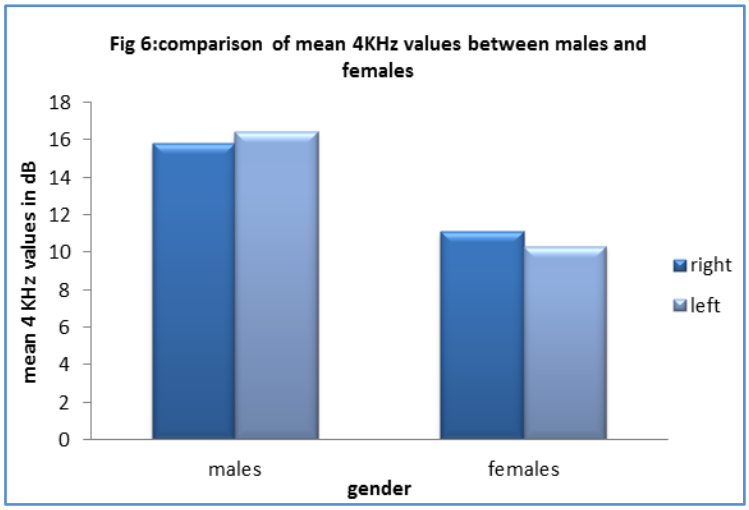
- Of the 103 subjects, 13 listened to soft, 58 listened to moderate, 26 listened to loud, 3 listened to very loud and 4 listened to combined volume settings.
- Reviewing the results of audiometry, we found that the median hearing threshold in the overall population analyzed was 13(10-15) dB [Median (IQR)] on the right side and 12 (10-15) dB [Median (IQR)] on the left side. Mean threshold in males was 14.97±4.5 dB (mean ±SD) on the right side and 14.46 ± 4.7dB (mean ±SD) on the left side. Mean threshold in females was 12.54 ± 3.7dB (mean ±SD) on the right side and11.62 ± 3.6dB (mean ±SD) on the left side. Mean threshold was higher in males when compared to females.



- Median hearing threshold at 4 kHz were 10(10-15) dB on the right side and 10(5-15) dB [Median (IQR)] on the left side. Mean hearing threshold at 4KHzin males' was15.8 ± 7.4 dB (mean ±SD) on the right side and on 16.4 ± 6.8 dB (mean ±SD) the left side. Mean threshold at 4 KHz in female was 11.10 ± 5.4 dB (mean ±SD) on the right side and 10.29 ± 5.5 dB (mean ±SD) on the left side. Mean threshold at 4 KHz was higher in males than in females.



- The median threshold of common bone conduction was 5(5-8) dB [Median (IQR)].

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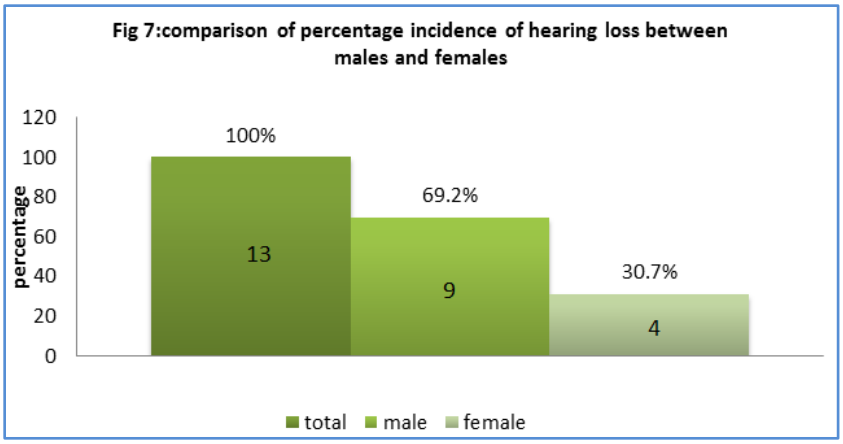
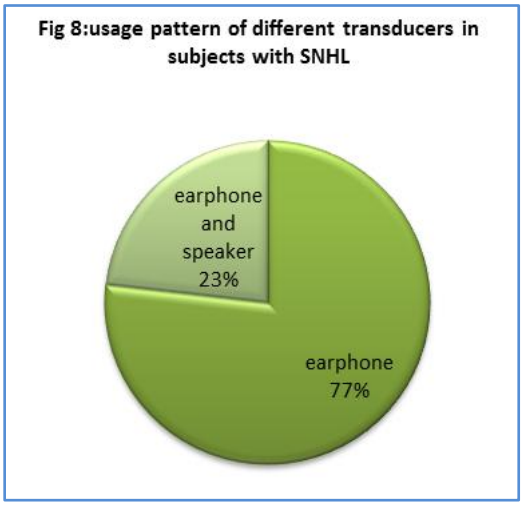
PREVALENCE OF HEARING LOSS:

- Of the 103 students subjected to audiometry, 13(12.62%) had Hearing loss.
- Of the 13 subjects with sensorineural hearing loss (SNHL), 9(69.2%) were males and 4(30.7%) were females showing a male predominance.



- 5 subjects had bilateral dip at 4 kHz (mean dip= 30 dB), 1 subject had bilateral dip at 8 kHz (30 dB), 1 subject had bilateral dip at 1 kHz (30 dB).5 subjects had unilateral dip at 8 kHz (mean dip=38.3 dB). 1 subject had unilateral dip at 4 kHz (35 dB) and 1 kHz (30 dB) in the right and left ear respectively.
- 10 out of 13 subjects with SNHL used earphones(contact transducers) while 3 subjects used both earphones and speakers(contact and non-contact transducers).Incidence of hearing loss was found to be more amongst subjects using contact transducers. But no statistically significant association was found between hearing loss and type of transducer.



- 1(11%) out of 9 subjects listening for less than 2 years, 10(14.9%) out of 67 subjects listening for 2-5 years, 2(7.4%) out of 27 listening for more than 5 years had SNHL (not statistically significant)

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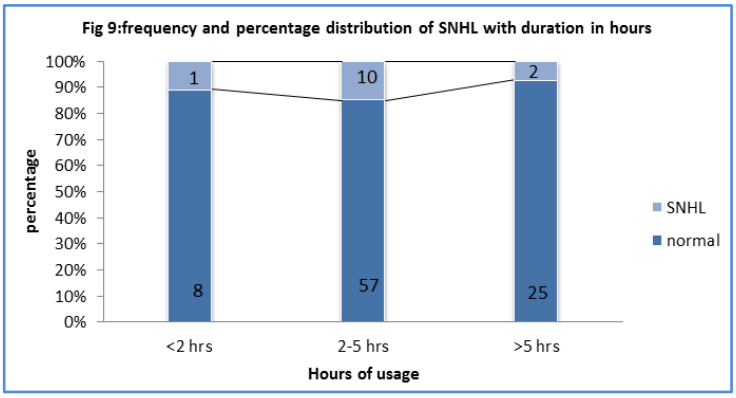
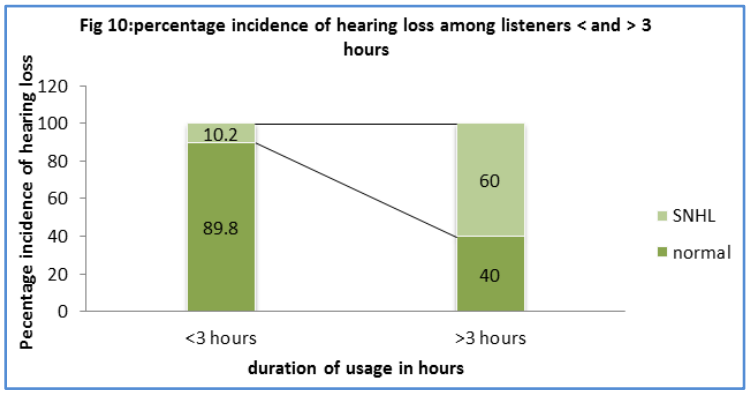
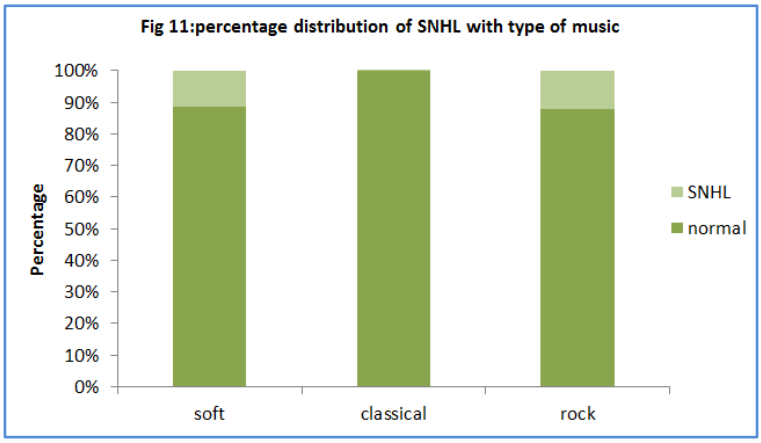


- 10(10.2%) of the 98 subjects who listened to personal music players for less than 3 hours a day had hearing loss while 3(60%) out of the 5 subjects who listened to more than 3 hours per day had hearing loss.
- It was found that people who listen to music for more than 3 hours per day had 13 times increased risk of hearing loss which was statistically significant (p= 0.001).



- 8 (11.5%) out of 69 subjects listening to soft, 1 (0.06%) out of 16 subjects listening to classical, 6 (12%) out of the 50 subjects listening to rock music had SNHL. No Statistically significant relationship was found between hearing loss and the type of music.



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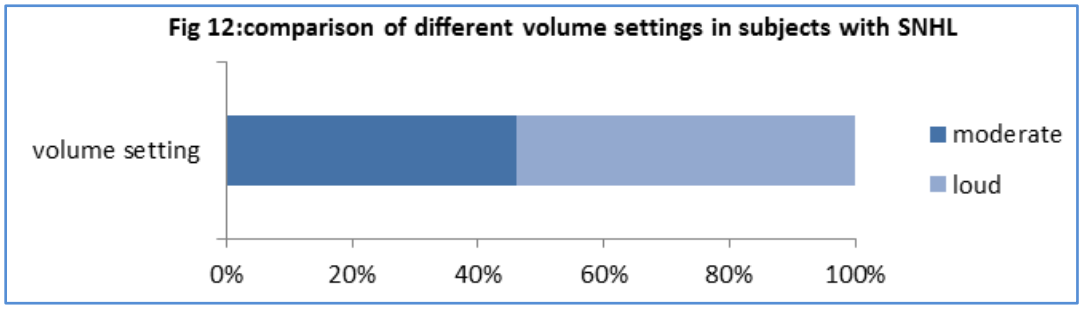
- None out of 15 subjects listening to soft settings, 6 out of 61 subjects listening to moderate volume settings, 7 out of 28 listening to loud volume settings, none out of 3 subjects listening to very loud volume settings had hearing loss.
- Out of the 13 with hearing loss, 6(46.16%) subjects listened to moderate volume settings (p=0.3, p value not statistically significant) while 7(53.84%) listened to loud volume settings (p=0.021, p value statistically significant).



DISCUSSION: NIHL begins with a temporary threshold shift (TTS). A TTS is defined as a temporary neurosensory hearing loss that recovers almost completely once the stimulus is removed. The extent of a TTS depends on intensity, frequency, content, and temporal pattern of noise exposure (i.e. intermittent or continuous). Pure-tone and narrow-band stimuli result in a maximum TTS at or slightly above the center frequency of the noise producing it.

Continuous stimuli are more damaging than interrupted stimuli. Intermittent noise is more protective for apical lesions induced by low frequencies than for basal lesions induced by high frequencies.

The importance of TTS is that it is rarely apparent to the subject because of its relatively low magnitude and relatively high frequency. Repeated TTSs over weeks, months, and years fail to recover completely and thereby become a permanent threshold shift (PTS).

NIHL starts with selective loss of hearing at around 4000 Hz. This is recognized on an audiogram as a notch centered around 4000 Hz and, although not pathognomonic, it is the characteristic audiometric pattern of early NIHL. If exposure is continued, the notch gradually deepens and widens. Eventually, hearing loss appears as a relatively steep high-frequency loss beginning at 3000 Hz and becoming more severe at each higher frequency over a period of many years. Persistent noise exposure progressively encroaches on the middle frequencies. In the most severe cases, even the lower frequencies may eventually become involved.

Clinical features are difficulty in understanding speech when a high level of ambient background noise is present. As NIHL progresses, individuals may have difficulty understanding high-pitched voices even in quiet conversational situations.

Many patients experience tinnitus associated with both TTS and PTS. Because repeated TTS slowly converts to PTS, post exposure tinnitus and TTS serve as warning signs of impending permanent NIHL.

Audiograms immediately after exposure and again 24 hours later should be attained to establish the presence or absence of TTS or PTS. From time to time, such testing may need to be repeated on several occasions.

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The 4-kHZ notch appears to be a consequence of several factors: (1) the fact that human hearing is more sensitive at 1-5 kHz, (2) the fact that the acoustic reflex attenuates loud noises below 2 kHz (as demonstrated by Borg), and (3) nonlinear middle ear function as a result of increased intensities.

TTS are reversible, but PTSs are not. Once PTS has set in, no treatment is available. However, hearing loss should not progress if exposure to the injurious noise is eliminated. Moreover, as the severity of the hearing loss increases, the rate of progression decreases, provided the injurious stimulus remains constant.

Outer hair cells are more susceptible to noise exposure than inner hair cells. Temporary threshold shifts (TTS) are anatomically correlated with decreased stiffness of the stereocilia of outer hair cells. The stereocilia become disarrayed and floppy. At a minimum, permanent threshold shifts (PTS) are associated with fusion of adjacent stereocilia and loss of stereocilia. With more severe exposure, injury can proceed from a loss of adjacent supporting cells to complete disruption of the organ of Corti. Histopathologically, the primary site of injury appears to be the rootlets that connect the stereocilia to the top of the hair cell. With loss of stereocilia, hair cells die. Death of the sensory cell can lead to progressive Wallerian degeneration and loss of primary auditory nerve fibers.

NIHL from constant noise exposure may be secondary to accumulated microtrauma and have a similar mechanism to injury produced from impulse noise. On the other hand, TTS may be due to metabolic exhaustion. Consequently, TTS is sometimes referred as auditory fatigue. Metabolic exhaustion sustained for prolonged periods may be so profound as to result in cell death. The concept of auditory fatigue as an explanation for TTS (with an opportunity for recovery if the noxious acoustic stimulus is removed) may account for the well-described clinical fact that intermittent noise is much less likely to produce permanent injury than continuous noise at the same intensity level.

Other physiologic conditions that affect the likelihood and progression of NIHL have been identified. Evidence appears in the literature that decreased body temperature, increased oxygen tension, decreased free radical formation, can reduce an individual's sensitivity to NIHL. Hypoxia potentiates the noise-induced damages. Good experimental evidence shows that sustained exposure to moderately high levels of noise can reduce an individual's sensitivity to NIHL at higher levels of noise. This process is referred to as sound conditioning.

A daily exposure of 85 dB (A) for 8 hrs is about the limit people can tolerate without substantial damage to hearing[1]. Previous investigators have demonstrated that maximum output Levels from headphones can exceed safe levels .Free-field equivalent sound pressure levels measured at maximum volume control setting ranged from 91 dB(A) to 121 dB(A).

More males than females are reported to have noise-induced hearing loss (NIHL). In agreement with the results of previous study[6], the mean thresholds in males were higher when compared to females and the mean threshold in the right ear was higher than that in left ear. Also the mean threshold at 4 KHz was also significantly higher in males when compared to females.

Hearing loss was also found more in males than in females. Out of the 35(100%) males we subjected to audiometry, 9(25%) had hearing loss while only 4 (5.88%) of 68(100%) females had hearing loss which was statistically significant.

Although preferred listening levels in quiet environments may be at acceptable levels, the addition of background noise will add to the overall noise exposure of a listener [6]. It was found that subjects with hearing loss used moderate to loud volume settings.

Though no hearing loss has been documented in a study done on Korean adolescents[7], we documented 13(12.6%) subjects using personal music players with hearing loss. Although they did not complain of tinnitus or any difficulty in hearing, we found significant dip (mean =34.6 dB) at high frequencies (4 KHz and 8 KHz). Although dip at 8 kHz is not characteristic of NIHL, it may be regarded as an initial sign of SNHL in subjects listening to personal music players.

In our study, it was found that people who listen to music for more than 3 hours per day had 13 times increased risk of hearing loss which was statistically significant (p= 0.001). We have seen that 40.8% of the subjects listened to 1-3 hours per day and 4.9% listened to more than 3 hours per day making them very vulnerable to hearing loss caused by the use of personal music players.

Furthermore 83.3% of the subjects used contact transducers predominantly. Subjects with hearing loss, predominantly used earphones as the transducer (although this was not found to be statistically significant). These findings indicate that the use of earphones and headphones has a greater impact on development of hearing loss.

Although the number of years of usage and type of music were not found to be having a statistically significant relationship to the elevated thresholds, they may add cumulatively. Usage for many years and listening to loud (rock, metallic) music may be considered risk factors for hearing loss.

CONCLUSION AND SUMMARY: People with age 18-25 years are exposed to personal music players. In the 103 subjects using personal music players, who were subjected to audiometry in our study, we found that 12.6% of the subjects had SNHL. Thresholds at 4 KHz and 8 KHz were affected. The mean dip of thresholds at high frequencies was 34.6 dB. These subjects did not complain of hearing loss or of tinnitus, as it is a high frequency hearing loss. As this hearing loss is not reversible, it is advisable to use the players intermittently with low volume. People who listen to music for more than 3 hours per day had 13 times increased risk of hearing loss. There was a significant relationship between SNHL and listening music at loud volume settings. Though other parameters like years of usage, type of music and use of contact transducers like earphones did not show statistical correlation, they could compound the harmful effects.

We conclude from our study that there is a direct relationship between usage of personal music players and hearing. If detected early, hearing loss can be reversed. But if permanent threshold shift occurs, hearing loss may become irreversible.

Thus the purpose of our study was, to assess whether music players affect hearing and to sensitize young of the harmful effect of music players if not used judiciously.

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