

EVALUATION OF HEARING ACUITY IN YOUNG ADULTS USING PERSONAL LISTENING DEVICES WITH EARPHONES

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Background: There is a growing concern regarding the hearing health of the young adults, because now a day the usage of personal listening devices and mobile phones with earphone or headphones has increased tremendously in youth. Long term use of these devices with high intensity of sound could bring irreversible damage to auditory system. **Aim and Objective:** The aim of this study is to investigate the hearing acuity of young adults using personal listening devices (PLDs) with earphones and nonusers and to evaluate effect of listening habits on hearing. **Materials and method:** It is a comparative study. Total 500 subjects selected randomly containing two subgroups 250 subjects of test group using earphones and 250 subjects of control group not using earphones from both the sex between age group of 18 – 40 yrs. Before commencing pure tone audiometry on total 500 subjects, questionnaire was filled by subjects regarding age, sex, self-reported hearing problem, duration of usage and type of personal listening devices used by them. The data obtained is statically analysed by SPSS version 19 and chi square method.

Results: Our results showed significant differences in mean hearing threshold level at low and high frequency in right and left ear between test group and control group. In present study we obtained significant fair positive correlation between mean hearing threshold level and usage of sound devices/day/year in Rt and Lt.ear with Low and high frequency. Our results also revealed that significant association is found between usage of earphone/day and hearing impairment. **Conclusion:** Usage of personal listening devices with earphones for longer time with high intensity of sound leads to early hearing loss and the frequency of mean hearing threshold level is higher in earphone users than nonusers.

Key Words: Ear phones, mean hearing threshold, hearing acuity.

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Introduction:

In the 70's portable music became available with the portable cassette players. During the 80's more than a third of young people, 11-18yrs, owned a portable cassette player¹ Later in the 90's, technically improved and lower costs portable music players were available and digital MP3-players (music player) were introduced and became popular in younger generation.² Portable electronic devices such as smartphones, tablets and computers, with earphones, became a common and natural part of everyday life. The unit sales in Europe for all portable audio have increased and nowadays most of mobile phones include an audio playback function.^{3, 4} Today most young people use portable music listening devices (PLDs) with earphones, due to the convenience of listening to music anytime and anywhere. However, they are not aware about risk of damage to hearing due to excessive use of personal listening devices with earphones. The average use

in young people has been reported to about 2 hours per day and the prevalence of PLD's has tripled in the last two decades.^{3, 4, 5, 6}

With the increased availability and use of personal audio devices for listening to music the threat of hearing impairment is increased, due to exposure to noise & their use at high volume over long periods.

In India also from 2001 to 2008, personal music player use rose fourfold, from 18.3% to 76.4% and High-frequency hearing loss increased from 12.4% to 19.2% during these years. According to the Indian council of medical research, hearing impairment is on the rise in India, and 1 out of every 12 people is a victim. Nearly 6.3% of the Indian population suffers from progressive and acute hearing loss. Doctors believed that rise in hearing impairment may be life style related hearing impairment, which is the new fear and is avoidable.⁷

Doctors say that about six youths visit a clinic every month complaining about hearing loss. According to a research conducted on 3,000 young adults in Mysore by the All India Institute of Speech and Hearing's audiology department, 66% of them listened to the music using modern gadgets, 8% reported reduced hearing temporarily, 9.7% reported to have ringing sensation in the ear, 4.5% reported blocking sensation in the ear, 5.6% reported heaviness in the ear, 7% reported irritation in the ear and 13.4% reported having headaches after listening to music.⁸

Excessive use of these devices may cause irreversible damage to hearing¹, in the short or long term.² Cochlea contains limited number of hair cells which are incapable to regenerate once damaged resulting in permanent hearing loss.^{9, 10} Most of music lovers are unaware that they are putting themselves at risk of sensorineural hearing loss. Chronic exposure to high intensity sounds can cause permanent hearing loss of an average 85 decibels or higher.¹¹⁻¹³ Most people become used to listen personal listening devices with head phones/earphones at high volumes or increase their volumes after some time of prolonged use; which may indicate an on-going permanent hearing loss in that individuals¹⁴⁻¹⁶. Both the intensity and duration of noise exposure; determine the potential for damage to the hair cells of the inner ear^{17,18}. In a survey Chung JH et al concluded that young individuals consider recreational noise induced hearing loss as a low priority health risk¹⁹ So the purpose of this study is to investigate the risk of hearing damage due to the use of various ear sound devices, for entertainment in Indian adults.

Material and Methods:

Study was carried out at audiology lab of GCS I hospital & Research centre, Ahmedabad. Before commencing work ethical clearance was obtained from institutional ethics committee. It is a control trial study held on 500 male and female subjects selected randomly between age group of 18-40 years. Subjects using personal listening devices for more than 2 hours included in study and those who are using hearing aids were excluded from the study. Two subgroups were formed. Control group consist of subjects who were not using personal listening devices and test group subjects were using

personal listening devices for more than 2 hours/day. Before commencing audiometry written consent of subjects were taken. Test procedure was explained and questionnaire regarding self-reported history of hearing problem, type of listening device used, duration of usage per day and per year and volume setting was taken.

Audiometric test: Performed in sound proof room with diagnostic (Elkon – Eda – 3n3) pure tone audiometer with headphone. Procedure was demonstrated to subject before starting work & instructions were given to subjects to indicate whether he or she can hear a certain sound or not. Pure tone audiometry was performed at frequencies of 250,500,1000,2000,4000 and 8000 HZ, and intensity of sound was ranging from 10-120dB.

Statistical analysis was done by SPSS version 19. (SPSSInc.Chicago, IL, USA) Data for continuous variables were expressed as mean± SD. The differences in listening habits like duration of usage time and usage period and volume level between genders were tested using the unpaired t test. Chi square analyses were conducted by Pearson's correlation test. Significance level was set at $p < 0.005$.

Results:

The present study investigated the usage of personal listening devices with earphones and their possible impact on hearing in age group between 18 to 40 years. Mean age of test group was 24.88 ± 5.82 years and control group was 26.94 ± 7.22 years. In this study we compared audiometric observation regarding mean hearing threshold level in test and control group and also shown relationship between users listening profile i.e. usage time/hr/day and also period of usage in years with hearing loss. Table – 1 show demographic descriptions of test and control subjects regarding age and sex.

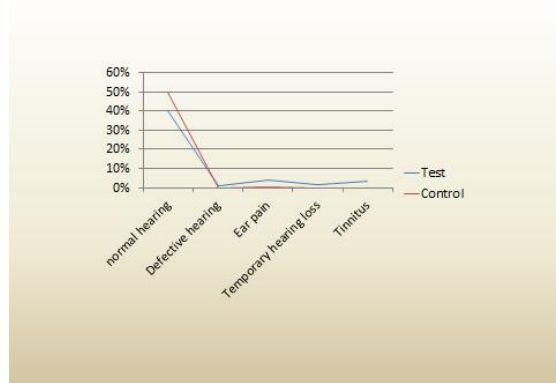
Table – 1
Demographic descriptions

Variable	Test Group n = 250 (%)	Control group n= 250 (%)
Gender		

Male	111 (22.2)	141 (28.2)
Female	139 (27.8)	109 (21.8)
Age (in completed years)		
18-25	155 (31)	124 (24.8)
26-33	71 (14.2)	75 (15)
34-40	24 (4.8)	51 (10.2)
Mean age	24.88 ± 5.82	26.94 ± 7.22

Out of 250 subjects of test group 111(22.2%) were male and 139(27.8%) were female and out of 250 control group subjects 141(28.2) were male and 109(21.8) were female. Mean age of male subjects of test group was 26 ± 5.0 and mean age of female subjects was 23 ± 5.0 . Mean age of control group male is 27 ± 6.0 and female subject is 27 ± 7.0 .

From data obtained from self-reported history of hearing problem it was observed that out of 250 subjects who were using personal listening devices 200(40%) subjects were not having any hearing problem 5(1%) subjects were having defective hearing, 19(3.8%) subjects were having complain of ear pain, 8(1.6%) subjects were having temporary hearing loss and 18(3.6%) subjects complaint about tinnitus. In control subjects only one subject having complain about ear pain, in others hearing problem is not found. Results regarding self reported hearing problems of test group and control group compared, it shows highly significant difference between them and $P < 0.001$.



From 250 subjects of test group 76% subjects were using only mobile phones as a listening device, 19% subjects were using more than one listening device, 4% subjects were using more than 2 listening devices, 1% subjects were using other listening devices than phone, computer and laptop. Most of the subjects were using in ear (earbud type) earphones, some subjects were using over the ear (headphones) earphones, handsfree etc. In reviewing audiometric test we found that mean hearing threshold level in test group were higher than control group with high and low frequency in Rt. Ear and Lt. Ear. is shown in table – 2.

Table – 2
Comparison of mean hearing threshold level between test and control group.

Mean hearing threshold level	Test group	Control group	t value	P value
Low frequency Lt.ear. (5 – 2kHz)	25.52 ± 8.25	15.04 ± 5.43	16.77	< 0.001*
Low frequency Rt.ear	24.86 ± 7.12	14.37 ± 5.50	18.42	< 0.001*
High frequency Lt.ear (4-8KHZ)	29.23 ± 11.10	15.64 ± 5.53	17.33	< 0.001*
High frequency Rt.ear	28.45 ± 10.58	15.18 ± 5.44	17.64	< 0.001*

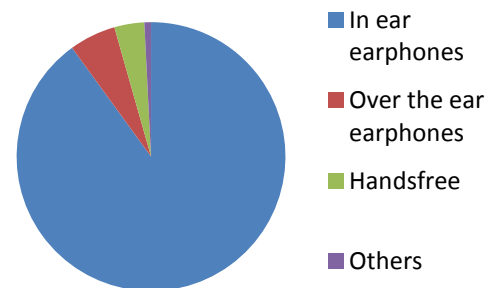
In the present study significant differences were found in mean hearing threshold level at low and high frequency in right and left ear between test group and control group. Hearing thresholds of PLDusers significantly higher at high frequency. P value is <0.001 which is stastically highly significant. In 10.4% PLD users V notch is also recorded on audiogram, which is a characteristic of early Noise Induced Hearing Loss Audiogram.(NIHL) Present study shows minimal to moderate sensorineural hearing loss in PLD users than nonusers. In subjects using PLD 116(23.2%) 134(26.8%) subjects mild to moderate hearing loss was present in Rt.ear and 119(23.8%)subjects normal hearing was found in Lt.ear and mild to moderate hearing loss was present in 130 (26%) and in 1(0.2%) subject severe hearing loss was present. In subjects not using PLDs hearing loss was not found. Our result shows stastically highly significant difference between test group and control group. P value is 183.06 and P (<0.001**) for Rt.ear and 173.5 (< 0.001**) for Lt.ear Present study also found that hearing acuity is affected by listening habits of young adults like duration of usage of the earphones and volume settings of devices. In this study self-reported listening volume settings is considered. As per the usage of various sound devices subjects were divided in three subgroupssee table – 3.

Table - 3
Listening profile of subjects:

Variable	Frequency (n)(%)
Type of ear phone	
In Ear(Earbud type)	225 (90)
Over the ear (headphone)	14 (5.6)
Hands free	9 (3.6)
Other	2 (0.8)
Usage of earphone hrs/day	
≤ 3	197 (38.8)

4 to 6	42 (16.8)
> 6	11 (4.4)
Mean usage	2 ± 0.12
Usage of earphone in yrs	
≤ 3	150 (60)
4 to 6	92 (36.8)
>6	8 (3.2)
Mean usage	1.5 ± 0.16

Figure 1:Distribution of study participantsas per Type of earphone used



In this study we found the relationship between the hearing frequencies,i.e. mean hearing threshold level at low and high frequency and in Left and Right ear of test group with duration of usage in hours/day & in years.

In present study we obtained significant fair positive correlation between mean hearing threshold level and usage of sound devices/day/year in Rt.ear and Lt.ear with Low and high frequency. P≤0.001.

.In present study we also found strong association between exposure to PLDs/ hrs/day and in yrs. Total 197 (78.8%) Subjects were using PLDs for≤ 3hrs.In 95(36.8%) subjects bilateral minimal to moderate hearing loss was found. 42(16.8%) subjects were using PLDs with earphones for 4 to 6 hrsamong them in 31(12.4%) subjects minimal to moderate hearing loss was found in Rt ear and 30 (11.2%) subjects were having mild to moderate

hearing loss and in Lt ear and in 1(0.4%) subject severe hearing loss was found. 11(4.4%) subjects were listening PLDs for more than 6 hrs and minimal to moderate hearing loss was found in all of them.

Present study also shows highly significant association between period of usage of earphones in years and bilateral hearing loss. In present study percentage of mild to moderate hearing loss increases as period of exposure to PLDs with earphones increases in years from ≤ 3 yrs to > 6 yrs. 150 (60.0%) subjects were using earphones for ≤ 3 yrs and from that in 25.6% subjects mild to moderate hearing loss was found in Rt.ear and 25.2% subjects in Lt ear, and in 1 subject severe hearing loss was found. 92(36.8%) subjects were using earphones for 4-6 years from that mild to moderate hearing loss found in 24.8% subjects in Rt ear and 23.8% subjects in Lt.ear, 8(3.2%) subjects were using earphones for more than 6 yrs. From that mild to moderate hearing loss was found in 3.2% subjects in Rt and Lt.ear. The results of present study shows statistically highly significant difference in hearing loss and period of usage of earphones in years ($P < 0.001$).

So it is observed that as duration of exposure increases the prevalence of hearing impairment increases.

In present study we have also evaluated the effect of self reported volume settings on mean hearing threshold level. As reported by subjects about volume of listening which they used to hear various sound devices they are classified in four groups. 20(8%) subjects were using low volume settings for hearing, 115(46%) subjects were using medium volume setting for hearing, 92(36.8%) subjects were using loud volume for hearing and 24(9.6%) subjects were using combined volume settings for hearing means subjects switch over from medium volume setting to loud volume setting and loud volume setting to medium volume setting. Our results show statistically significant difference in Lt.ear ($P < 0.005$) and highly significant difference at high frequency in Rt.ear, Lt.ear and with low frequency in Rt.ear ($P < 0.001$). Shown in table - 4.

Table - 4

Sound level Comparison of mean value of frequency among test group

Sound Level	Low F right ear	Low F left ear	High F right ear	High F left ear
Low	22.46 ± 5.45	22.85 ± 5.76	23.64 ± 6.36	24.98 ± 7.92
Medium	23.23 ± 6.28	23.88 ± 6.69	25.16 ± 7.67	26.05 ± 8.18
Loud	27.14 ± 8.19	27.96 ± 10.43	32.50 ± 12.79	32.78 ± 13.33
Combine	26.02 ± 5.09	26.35 ± 4.12	32.86 ± 9.26	34.57 ± 10.44
F Value	6.48	5.19	12.44	10.08
P Value	<0.001**	0.002*	<0.001**	<0.001**

* Statistical significant difference $P < 0.05$; ** Statistical highly significant difference $P < 0.001$

Our Studies have shown that usage of PLDs with earphones/headphones, for a period of two hours is sufficient for subsequent hearing impairment. It was also found that listening to loud music directly into the ear can damage the sensitive hair cells in the inner ear^{2-4, 6, 28-30}

Discussion: The present study examined the relationship between usage of PLDs with earphone/headphone and hearing acuity among 18 to 40 years of age and to assess the risk of hearing damage due to improper use of these devices in adolescents.¹⁹ Nowadays, adolescents and young adults consciously expose themselves to loud noise or music for long periods of time and they are unaware of its consequence.

Detailed population studies about the usage of current PLDs among adolescents and their possible impact on hearing, is limited. Prior studies involved small groups of PLD users and it is difficult to generalize their conclusions for other populations. The present study investigated the usage pattern of PLDs in a Indian population in Gujarat, Ahmedabad, and evaluated the potential risks of

hearing damage in PLD users with headphone/earphone. (PLD users)

According to some studies subjects who were using earphones for longer time may be having some hearing problems. This problem can be confirmed in present study. According to self reported hearing history of participant's, 28% participants of test group have at least one auditory symptom. Such findings correlates with the literature which reports that prolonged exposure to noise can affect quality of life. Out of 28% subjects were having atleast one auditory symptom like pain in ear, temporary hearing loss, earache etc. 18% subjects were having complain of ringing or humming sound in absence of external sound known as tinnitus which indicates pre mature hearing problem.^{20, 21}

In reviewing audiometric test we found that mean hearing threshold level in test group were higher than control group at high and low frequency in Rt. Ear and Lt.ear.

Results of present study about mean hearing threshold value are similar to study held on students of the urban medical university of India.²²Results of present study is also supported by study of Peng et al (2007) based on audiometric testing of 120 personal music players users and 30 normal-hearing young adults, it was revealed that hearing thresholds in the 3 to 8 kHz frequency range were significantly poorer in the group using PMPs.²³Also, in some of the PMPs(Personal music players)users, the hearing thresholds were worsen with high-frequency audiometry eventhough their hearing thresholds in conventional frequency audiometry were normal. The results of present study is also supported by study of Portnuff and study ofOgbe et al held in Nigerian male and female headphone users and non-users.^{24,25}The results of presentstudy is not supported by study of Kim et al held in Korean adolescents and study of Keppler held inyoung adults and Sulaiman . They have not found significant difference in mean hearing threshold level between PLDs users and non-users^{26,27}

Present study also investigated that hearing acuity is affected by listening habits of young adults like duration of usage of the earphones and volume settings of devices. In this study self reported listening volume settings is considered.

In present study 78.8% participants were using PLDs with earphones for more than 2hrs. Results of present study show positive correlation between usage time of PLDs with earphones in hours and period of usage of earphones in years. Results of present study is supported by study ofSulaiman et al and Widen etal ,who found significant differences between two groups, One using earphones to listen music for less than 3 hrs and other group using it for more than 3 hrs and he found poorer hearing threshold in adolescents using listening devices with earphones more than 3hrs.^{28, 29} Results are also supported by study of Taneja et al.³⁰

Present study also shows highly significant association between usage time and period of usage of earphones in years and bilateral hearing loss. In present study percentage of mild to moderate hearing loss is higher in participants, using earphones more than 3hrs and more than 3yrs. The results of present study show statically highly significant difference in hearing loss and time of usage of earphonesin hrsand period of usage of earphones in years ($P < 0.001$). In present study subjects using PLDs with earphones more than 2hrs were included and in 50% of them minimal to moderate hearing loss is found. Results of present study are supported by study of Pengetal and Zia S et al. Study of Peng et al showed that the hearing lossfound in 14.1% (34 of 240) of ears following long-term use of PLDs.Study of Zia s et al found hearing loss in 11(19.6%) participants using earphones for 3-4 hours and 36(64.2%) using earphones for 5-6 hrs. in Pakistan.^{18, 24}

In present study we have also evaluated the effect of self reported volume settings on mean hearing threshold level (HTL). As reported by participants about volume of listening they used to hear various sound devices. The results of our study showed significant differences in mean hearing threshold level among the four audiometric groups into which participants were classified. These differences were especially evident in the high frequency range. Groups 2(medium sound volume) slight shift of HTL and 3(loud sound volume) and 4(combined sound volume) significant shift of HTL compared to Group 1(low sound volume) normal HTL, revealed an increase in HTL in all frequencies. These results are consistent with the idea that high

frequency ranges are more sensitive to noise, as found in previous studies.

Conclusion:

From the results of present study it is concluded that, PLD users with earphones have significantly higher hearing thresholds than Non users and high frequencies are affected more. Long term use of PLDS can impair hearing function and leads to hearing loss. Loud volume setting is also having damaging effect on hearing. Further investigation on a larger population of PLD users is needed to examine the complex relationship between listeners profile about PLD use and hearing loss is needed.

Limitation:

Data collected was relying on self reported measures about duration of PLDs usage and volume settings.

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