

## Research Article

# Effect of chronic use of mobile phone on hearing of young adult age group: a case control study

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## ABSTRACT

**Background:** Exposure to noise from mobile devices is suspected to affect hearing. Objective: To study effect of chronic use of mobile phone on hearing of young adult age group.

**Methods:** The present study is randomized comparative case control study conducted at GMERS Medical College, Dharpur-Patan, North Gujarat, India during March 2014 to August 2015 in which 60 subjects within age group of 15-40 years were included without history of ear disease, ear complains, noise induced trauma to the ear and exposure to noisy environment. After taking written and verbal consent and approval from ethical committee 60 healthy volunteers using the mobile phones infrequently less than 15 minutes a day were included in control group and 60 healthy volunteers using the mobile phones more than 1 hour a day with individual dialogue period more than 30 minutes at a time in a day, for more than 1 year were included in study group. After all the necessary clinical examinations, all subjects were taken in audiometry room for Pure Tone Audiometry in both ears using Pure Tones of 250 Hz- 8000 Hz Frequencies with pure tone audiometry instrument. The collected data were analyzed using SPSS 17 (trial version).

**Results:** The mean age of study group was  $(26.17 \pm 2.65)$  years and that of control subjects was  $(26 \pm 3.93)$  years. The mean usage of mobile phones for study group was  $106.0 \pm 40.73$  minutes and for control group was  $9.33 \pm 3.65$  minutes, the difference was found statistically significant. The mean hearing loss at high frequencies in both ears in study group was  $8.47 \pm 4.15$  dB and in control group was  $0.33 \pm 1.826$  dB that was statistically significant. Out of 30 subjects of study groups, 14 subjects (23.33%) had normal hearing, 32 subjects (53.33%) were having mild high frequency hearing loss and 14 subjects (23.33%) were having moderate high frequency hearing loss. Out of 60 subjects of study groups, 46 subjects (76.67 %) were having high frequency hearing loss (mean hearing loss of  $12.17 \pm 9.53$ ) in right ear, and 20 subjects (33.33 %) were having high frequency hearing loss (mean hearing loss of  $5.16 \pm 9.143$ ) in left ear. Out of 60 subjects of study groups, 24 subjects (52.17%) with history of tinnitus were having mild to moderate high frequency hearing loss. In 22 subjects (47.82%) with history of warm sensation in the ear were having mild to moderate high frequency hearing loss. In 12 subjects (26.08%) with history of earache were having mild to moderate high frequency hearing loss.

**Conclusions:** There is increase in mean hearing loss (especially at higher frequencies) with increase in duration of daily mobile phone usage. Hearing loss (especially at higher frequencies) is more marked in right ear (mobile phone using ear) as compared to left ear (non-mobile phone using ear). Mobile phone can have a deleterious effect on hearing threshold. Long term use of mobile phone can impair hearing function. Larger, longitudinal studies are needed on mobile phone use and hearing impairment.

**Keywords:** Mobile phone, Hearing Impairment, Hearing Loss, HFHL

## INTRODUCTION

Nowadays, vast majority of people are using mobile phones, more than 900 million mobile phone subscribers are there only in India. Mobile phones are the wireless communication system which uses electromagnetic waves to transmit the signal from mobile phone to mobile towers and vice versa. Although mobile phone use has proved to be lifesaving in certain circumstances (e.g., after accidents) and has helped improve the quality of life in some sectors, concerns continue to be raised about potential adverse health impacts associated with their use. As mobile phones are generally held close to the head during use, one of the concerns widely expressed has been that the radiofrequency (RF) waves emitted during use might lead to an increase in brain cancer risk.<sup>1</sup> Most Cellular and cordless telephones have either a small antenna attached or the antenna is integrated into the body of the telephone. Because the antenna of a mobile phone is close to the user's head, such telephones create greater RF exposure than other types of RF system.

Both GSM and CDMA mobile phones operate in the range of about 800 to 900 MHz. Our ears respond to sounds across a wide range of frequencies, from about 20 to 20 000 Hertz (Hz). Speech frequencies are roughly located between 250-8000 Hz. Low frequencies (250-2000 Hz) are used to "hear people" while the high frequencies (2000-8000 Hz) are what we use to understand what they say.

According to research presented at the American Academy of Otolaryngology-Head and Neck Surgery Foundation's Annual Meeting & OTO EXPO in Washington, DC, 100 people who had used mobile phones for over a year suffered increases in the degree of hearing loss especially at higher frequencies over the span of 12 months. Furthermore, the study also discovered that people who used their mobile phones for more than 60 minutes a day had a worse hearing threshold than those with less use.

The problem with hearing loss is that it is slow and gradual and people may not hear the difference until it is serious. The hearing loss was greatest in the dominant ear- the ear usually used for their mobile phone conversations. Noise-induced hearing loss also develops slowly over years, and is caused by any regular and consistent exposure exceeding a daily average of 85-90 dB.<sup>2</sup> It is also in the high frequency range. Hearing loss due to long term use of mobile phones due to inner ear damage caused by either EMWs or due to noise induced is still inconclusive.

Constant exposure to noise from mobile phone sources is suspected to adversely affect hearing and potentially lead to other adverse outcomes like cancers<sup>3,4</sup> but data are limited, particularly in rapidly urbanizing and growing

areas of less developed countries. The present study is a humble effort to throw light on effect of chronic use of mobile phone on hearing of young adult age group.

## METHODS

The study was conducted at GMERS Medical College, Dharpur-Patan, North Gujarat, India during March 2014 to August 2015. The present study is randomized comparative case control study in which 120 subjects within age group of 15-40 years were included without history of ear disease, ear complains, noise induced trauma to the ear and exposure to noisy environment. 60 healthy volunteers using the mobile phones infrequently less than 15 minutes a day were included in control group. 60 healthy volunteers using the mobile phones more than 1 hour a day with individual dialogue period more than 30 minutes at a time in a day, for more than 1 year were included in study group. The subjects, to be enrolled for the study, were informed about the study and procedure details and an informed consent was obtained. After all the necessary clinical examinations, All subjects were taken in audiometry room for pure tone audiometry in both ears using pure tones of 250 Hz- 8000 Hz frequencies with pure tone audiometry instrument. The collected data were analyzed using SPSS 17 (trial version). Data was expressed as mean value  $\pm$  standard deviation and corresponding 95% confidence intervals (CIs). Standard deviation has been used to indicate whether the variation of difference of an individual from the mean is by chance. The probability value (p) of less than 0.05 was considered statistically significant as it could be interpreted that the factor is less likely to occur due to chance, while a probability value of more than 0.05 was considered statistically not significant because such a difference could commonly occur due to chance and the factor under study may have no influence on the variables. Probability tests were performed based t test.

## RESULTS

Table-1 shows standard anthropometric measurements of long term mobile phone users (n=60) and infrequent mobile phone users (n=60). The mean age of study group was  $(26.17 \pm 2.65)$  years and that of control subjects was  $(26 \pm 3.93)$  years. The mean usage of mobile phones for study group was  $106.0 \pm 40.73$  minutes and for control group was  $9.33 \pm 3.65$  minutes, the difference was found statistically significant. The mean duration of a dialogue period of daily mobile usage in study group was  $42.50 \pm 15.30$  minutes and for control group was  $1.83 \pm 0.65$  minutes that was also found statistically significant. The Mean total years of mobile phone usage in study group was  $2.93 \pm 1.36$  years and in control group was  $3.10 \pm 1.06$  years which was statistically insignificant. The mean hearing loss at high frequencies in both ears in study group was  $8.47 \pm 4.15$  dB and in control group was  $0.33 \pm 1.826$  dB that was statistically significant.

Out of 60 subjects of study groups, 14 subjects (23.33%) had normal hearing, 32 subjects (53.33%) were having mild high frequency hearing loss and 14 subjects (23.33%) were having moderate high frequency hearing loss. 22 subjects with mobile usage <60 minutes per day, 10 subjects (45.45 %) were having mild high frequency hearing loss with mean hearing loss was  $8.15 \pm 3.68$  dB. In 30 subjects with mobile usage between 60-120 minutes per day, 28 subjects (93.33 %) were having mild to

moderate high frequency hearing loss with mean hearing loss was  $10.58 \pm 6.07$  dB. In 8 subjects with mobile usage between 120-240 minutes per day were having mild to moderate high frequency hearing loss with mean hearing loss of  $13.75 \pm 6.33$  dB. So, the present study clearly states that there is increase in mean hearing loss (especially at higher frequencies) with increase in duration of daily mobile phone usage (Table 2).

**Table 1: Anthropometric, mobile usage and hearing loss information of study & control group.**

	Study Group (n=30)	Control group (n=30)	P value
Age	26.17 ± 2.65	26 ± 3.93	>0.05
Height	168.27 ± 5.32	168.00 ± 4.14	>0.05
Weight	70.77 ± 4.99	71.23 ± 4.14	>0.05
Total duration of daily usage of mobile Phones (in minutes)	106.0 ± 40.73	9.33 ± 3.65	<0.05
Longest dialogue duration over mobile phones in a day (in minutes)	42.50 ± 15.30	1.83 ± 0.65	<0.05
Total duration of mobile usage (in years )	2.93 ± 1.36	3.10 ± 1.06	>0.05
Hearing loss in dB at 4000 Hz frequency in Right ear	12.17 ± 9.53	0.33 ± 1.83	<0.05
Hearing loss in dB at 8000 Hz frequency in Right ear	12.50 ± 10.15	0.33 ± 1.83	<0.05
Hearing loss in dB at 4000 Hz frequency in Left ear	5.16 ± 9.14	0.33 ± 1.83	<0.05
Hearing loss in dB at 4000 Hz frequency in Left ear	5.16 ± 8.85	0.33 ± 1.83	<0.05

**Table 2: Relationship between total duration of daily usage of mobile phones and hearing status.**

Total duration of daily usage of Mobile Phones (in minutes)	No of subjects	Mean Hearing loss in dB (at high frequencies)	Hearing Status		
			Normal	Mild HFHL	Moderate HFHL
<60	22	8.15 ± 3.68	12	10	0
60-120	30	10.58 ± 6.07	2	18	10
120-240	8	13.75 ± 6.33	0	4	4
Total	60	8.47 ± 4.15	14	32	14

HFHL- High frequency hearing loss

**Table 3: Relationship between longest dialogue duration over mobile phone & hearing status.**

Longest dialogue duration over mobile phones in a day (in minutes)	No of subjects	Mean Hearing loss in dB (at high frequencies)	Hearing Status		
			Normal	Mild HFHL	Moderate HFHL
30 - 45	30	4.08 ± 2.83	14	14	2
45 - 60	28	12.41 ± 5.68	0	18	10
> 60	2	30 ± 5.77	0	0	2
Total	60	8.47 ± 4.15	14	32	14

Out of 60 subjects of study groups, 30 subjects with mobile usage between 30-45 minutes per day during dialogue period, 16 subjects (53.33 %) were having mild to moderate high frequency hearing loss with mean hearing loss was  $4.08 \pm 2.83$  dB. In all 28 subjects with mobile usage between 45-60 minutes per day during dialogue period were having mild to moderate high frequency hearing loss with mean hearing loss of  $12.41 \pm 5.68$  dB. In 2 subjects with mobile usage between > 60 minutes per day during each episode was having

moderate high frequency hearing loss with mean hearing loss of  $30 \pm 5.77$  dB. So, the present study clearly states that longer the duration of dialogue period over mobile phone, higher is the mean hearing loss (especially at high frequencies) (Table 3).

Out of 60 subjects of study groups, 22 subjects with mobile usage for 1-2 years, 12 subjects (54.54 %) were having mild high frequency hearing loss with mean hearing loss of  $4.08 \pm 2.65$  dB. In 32 subjects with mobile

usage for 2-4 years, 28 subjects (87.5 %) were having mild to moderate high frequency hearing loss with mean hearing loss of  $8.43 \pm 4.08$  dB. In 6 subjects with mobile usage for > 4 years were having moderate high frequency

hearing loss with mean hearing loss of  $24.16 \pm 5.69$  dB. So, in present study there is increase in mean hearing loss (especially at higher frequencies) with increase in total years of mobile phone usage (Table 4).

**Table 4: Relationship between total duration of mobile usage (in years) and hearing status.**

Total duration of mobile usage (in years )	No of subjects	Mean Hearing loss in dB (at high frequencies)	Hearing Status		
			Normal	Mild HFHL	Moderate HFHL
1 - 2 years	22	$4.08 \pm 2.65$	10	12	0
2 - 4 years	32	$8.43 \pm 4.08$	4	20	8
> 4 Years	6	$24.16 \pm 5.69$	0	0	6
Total	60	$8.47 \pm 4.15$	14	32	14

**Table 5: Comparison of degree of hearing loss in right & left ears at 4000 Hz & 8000 Hz frequencies in mobile phone users.**

Frequency in Hz	Degree of hearing loss in dB in study subjects		No of subjects having hearing loss	
	Right ear	Left ear	Right ear	Left ear
4000 Hz	$12.17 \pm 9.53$	$5.16 \pm 9.143$	46	20
8000 Hz	$12.50 \pm 10.15$	$5.16 \pm 8.85$	46	18

**Table 6: Relationship between ear symptoms and severity of hearing loss mobile Phone users.**

Degree of hearing loss	H/o Tinnitus	H/o warm sensation in the ear	H/o Earache
Normal	0	0	0
Mild HFHL	10	10	4
Moderate HFHL	14	12	8
Total	24	22	12

Out of 60 subjects of study groups, 46 subjects (76.67 %) were having high frequency hearing loss (mean hearing loss of  $12.17 \pm 9.53$ ) in right ear, and 20 subjects (33.33 %) were having high frequency hearing loss (Mean hearing loss of  $5.16 \pm 9.143$ ) in left ear. This study clearly states that hearing loss (especially at higher frequencies) is more marked in right ear (mobile phone using ear) as compared to left ear (non-mobile phone using ear) (Table 5).

Out of 60 subjects of study groups, 24 subjects (52.17%) with history of tinnitus were having mild to moderate high frequency hearing loss. In 22 subjects (47.82%) with history of warm sensation in the ear were having mild to moderate high frequency hearing loss. In 12 subjects (26.08%) with history of earache were having mild to moderate high frequency hearing loss. This study clearly states that mobile phone users with ear symptoms like tinnitus, warm sensation in the ear, earache develop mild to moderate degree high frequency hearing loss (Table 6).

**DISCUSSION**

Our study clearly states that there is increase in mean hearing loss (especially at higher frequencies) with increase in duration of daily mobile phone usage. Similar

study by Nasab et al found that pure tone threshold of all subjects were in the normal range but there was a significant difference between mean pure tone threshold of user and non-users,  $+0.12 \pm 5.93$  dB and  $-3 \pm 4.73$  dB, respectively.<sup>5</sup> Duration of use was also related to threshold changes. This study is in tune with present study. Oktay et al found that no differences were observed between moderate mobile phone users (10-20 minutes per day) and control subjects.<sup>6</sup> However, detection thresholds in those who talked approximately 2 hours per day were found to be higher than those in either moderate users or control subjects. This study shows that a higher degree of hearing loss is associated with long-term exposure to electromagnetic (EM) field generated by cellular phones. This study is in tune with present study.

In present study there is increase in mean hearing loss (especially at higher frequencies) with increase in total years of mobile phone usage. Similar study by Panda et al states that high frequency hearing loss was observed with increase in duration of mobile phone use.<sup>7,8</sup> One- to two-year users had a 16.48 decibel loss in the high-frequency range, while those who used the phones more than four years had a 24.54 decibel loss. This study is in tune with present study. Sanjeev et al performed study on 75 subjects who used mobile phones for more than 4 years

and found that prolonged & frequent exposure to EMFs from mobile phones usage do not cause damage to the inner ear or cochlea as measured by DPOAE (distortion product otoacoustic emission). This study is not in tune with present study.<sup>9</sup>

This study clearly states that hearing loss (especially at higher frequencies) is more marked in right ear (mobile phone using ear) as compared to left ear (Non mobile phone using ear). Similar study by Sanjeev et al found no statistically significant difference of having absent DPOAE in dominant & non-dominant ears.<sup>9</sup> This study is not in tune with present study. Similar study by Kerekhanjarong et al found that in mobile phone users using more than 60 minutes per day, hearing threshold of the dominant ears was worse than non-dominant ears.<sup>10</sup> This study is in tune with present study.

Present study clearly states that mobile phone users with ear symptoms like tinnitus, warm sensation in the ear, earache develop mild to moderate degree high frequency hearing loss. Davidson et al studied symptomatology in 117 students using mobile phones for 0-45 minutes in a day for 0-7 years.<sup>11</sup> They concluded that high or long term users reported no worse hearing, tinnitus or balance than low or short term users. This study is not in tune with present study.

## CONCLUSION

Following conclusions were derived from our study.

1. There is increase in mean hearing loss (especially at higher frequencies) with increase in duration of daily mobile phone usage.
2. Longer the duration of dialogue period over mobile phone, higher is the mean hearing loss (especially at high frequencies).
3. There is increase in mean hearing loss (especially at higher frequencies) with increase in total years of mobile phone usage.
4. Hearing loss (especially at higher frequencies) is more marked in right ear (mobile phone using ear) as compared to left ear (Non mobile phone using ear).
5. Mobile phone users with ear symptoms like tinnitus, warm sensation in the ear, earache develop mild to moderate degree high frequency hearing loss.

Further studies on large sample size will be required to strengthen our knowledge on deleterious effects of long term and intensive mobile phone use on hearing. At present we can guide young mobile phone users with potentially longer lifetime exposure to cut short the dialogue periods and use the hand-sets for essential purposes only. By using speaker phones or hands-free system, the direct exposure to electromagnetic radiations

emitted by mobile phones can be minimized. Regular audiometric screening of all mobile phone users is recommended.

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