

## Original Research Article

# Study of the effect of mobile phones on hearing

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**Received:** 09 January 2021

**Accepted:** 10 February 2021

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## ABSTRACT

**Background:** The effect of mobile phone radiation on human health is the subject of recent interest and study as a result of the enormous increase in mobile phone usage throughout the world. The present study was designed with an objective to study the effect of mobile phones on hearing.

**Methods:** This cross sectional study involved cases in the age group of 18 to 45 years attending the out-patient department of ENT at Chhatrapati Shivaji Subharti hospital, Meerut. A total of 85 patients (mobile phone users) were taken for the study October 2018 to July 2020. Subjects with usage of mobile phones (smart phones) for a minimum of 2 hours a day and a minimum of 1 year duration (with or without ear phones), normal healthy individuals with no systemic disease, normal tympanic membrane with no prior external, middle/inner ear disease or discharge or trauma and subjects with type a tympanogram (on tympanometry) were included in the study. Degree of deafness was graded according to WHO classification, 1980

**Results:** Statistically significant p value was observed ( $<0.001$ ) while comparing SNHL with hours of exposure and years of exposure. Statistically significant p value was observed ( $<0.05$ ) while comparing hours of exposure with Tinnitus. Statistically insignificant p value was observed while comparing hours and years of exposure with other associated complaints; aural fullness, ear ache (otalgia) and warmth sensation in ear.

**Conclusions:** The present study shows an increase in the hearing threshold of the ear exposed to the prolonged use of mobile phones.

**Keywords:** Mobile, Radiation, Hearing, Deafness

## INTRODUCTION

Mobile phones are regarded as a pivotal instrument for an individual to remain informed and connected with the outside world. They are used to make and receive calls, which in turn receive and emit electromagnetic radiation.<sup>1</sup> The use of mobile phones started in the early eighties, and since then has increased exponentially.<sup>2</sup> India is considered the second largest market for smart phones and is expected to have 650 million users of smart phones by 2019.<sup>3</sup> Out of all anatomical structures, ear has one of

the closest proximity to mobile phones which may lead to relatively high hazardous effect on ear compared to other parts of the body.<sup>4</sup> Research has shown that approximately 40%-50% of the radiofrequency output from mobile phones is absorbed in the user's head.<sup>5</sup> Mobile phones transmit and receive signals using electromagnetic fields in the radiofrequency band. The global system for mobile communications (GSM) is currently the most widely used digital mobile phone service operating at 900 to 1,800 MHz frequency bands.<sup>6</sup> Phones emit a pulsed high frequency electromagnetic

field, which may penetrate the scalp and the skull.<sup>7</sup> The temporal region near the phone antenna appeared to be under the most intensive heating. Ultrahigh frequency radiation induces significant changes in local temperature.<sup>8</sup> The thermal effects of electromagnetic radiation include headache, sensation of warmth or burning around the ear, burning sensation on facial skin and alteration of the Blood-brain barrier.<sup>9</sup> RF exposure from mobile phones is concentrated to the tissue closest to the handset, which includes auditory nerve.<sup>10</sup> The extensive exposure to EMR has been found to affect a wide variety of brain functions.<sup>11</sup> There is a concern that these could damage the sensitive outer hair cells in the organ of corti. Various studies have been undertaken to assess the hearing status in long-term mobile phone users, but results are inconclusive.<sup>12-14</sup>

As exposure to this type of electromagnetic radiation is progressively increasing worldwide, there is a greater interest in its possible harmful effects on health.<sup>15</sup> Therefore; the effect of mobile phone radiation on human health is the subject of recent interest and study as a result of the enormous increase in mobile phone usage throughout the world. Keeping these aspects in mind, the present study was designed with an objective to study the effect of mobile phones on hearing.

## METHODS

The study involved cases in the age group of 18 to 45 years attending the out-patient department of ENT at Subharti medical college and associated Chhatrapati Shivaji Subharti hospital, Meerut. A total of 85 patients (mobile phone users) were taken for the study October 2018 to July 2020. Subjects with usage of mobile phones (smart phones) for a minimum of 2 hours a day and a minimum of 1 year duration (with or without ear phones), normal healthy individuals with no systemic disease, normal tympanic membrane with no prior external, middle/inner ear disease or discharge or trauma and subjects with type a tympanogram (on tympanometry) were included in the study. Subjects with perforation of tympanic membrane, otological/neurological/psychiatric disorders, history of ear discharge, conductive/mixed hearing loss, NIHL, trauma, diabetes mellitus, dyslipidemia, hypertension, central or peripheral nerve diseases, congenital hearing disorders, those using any ototoxic medications or smoking /alcohol were excluded from the study.

All the candidates were subjected to a detailed history taking with special emphasis on duration, pattern, usage of mobile phones and hearing loss. Detailed enquiry was made about onset and progression of hearing loss if any, and also associated symptoms like tinnitus, aural fullness, otalgia or warmth sensation over external ear. An insight regarding any underlying medical conditions like diabetes, hypertension or any other co-morbidities was also done to accede with the exclusion criteria. Any history of childhood ear discharge was also asked for.

The occupational exposure to loud noise and personal habits like smoking and alcohol were also asked for and excluded. Detailed clinical examination performed including a general systemic examination and thorough examination of the ear using otoscope. The character of the tympanic membrane was observed in detail. The three standard tuning fork tests (Weber's, Rinne's, and absolute bone conduction tests) were done. Tympanometry was done and only patients with type A tympanogram were included. All the candidates then underwent pure tone audiometry (PTA) and graph studies were plotted. Pure tone audiograms were assessed for type and percentage of hearing loss. Incidence of various associated complaints were also studied and compared with hours and years of exposure.

A pulse of tone was presented at a set frequency and set dB hearing level using adjustment knobs on the audiometer. Mode of response was by a pressing button. The subjects were familiarized with the tone. After the first response, the tone was decreased by 10 dB whenever the subject responded and was increased by 5 dB if the person fails to respond. The bone vibrator for bone conduction checking was placed on the mastoid process, no closer than a thumb's width to prevent acoustic radiation and diagnostic testing at 250, 500, 1000, 2000, and 4000 Hz was done as above. For assessing the hearing loss, pure tone average was calculated by taking the average of the hearing threshold levels at 500, 1000 and 2000 Hz, 4000 Hz only. Degree of deafness was graded according to WHO classification, 1980 as; 0 to 25 dB; normal hearing, 26 to 40 dB; mild deafness, 41 to 55 dB; moderate deafness, 56 to 70 dB; moderately severe deafness, 71 to 90 dB; severe deafness and >90 dB; profound deafness. Graphs plotted in line with the audiometry findings and results made as per the findings to assess the effect of mobile phones on hearing in relation with the hours, years exposed and hearing loss.

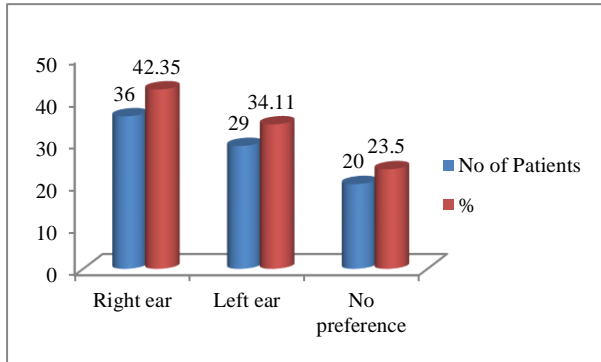
## Statistical analysis

Data calculations were done using statistical package for the social sciences software version 22.0. Chi square test was used to compare the two groups and the level of significance and  $p < 0.05$  was considered as significant.

## RESULTS

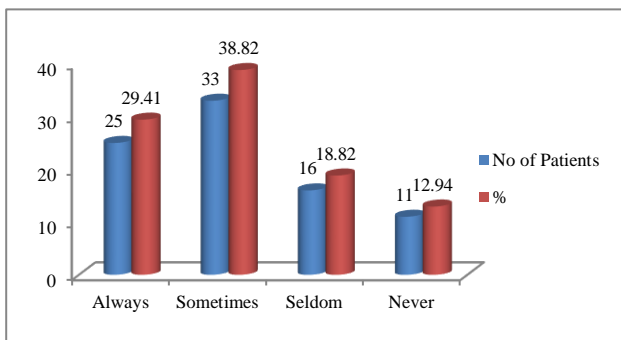
In current study, the age group ranged from 18-45 years. Out of 85 patients, 36 patients (42.35%) were males and 49 patients (57.64%) were females. Hearing loss and tinnitus were the main complaints of subjects in the study i.e. 31 (36.47%), 28 (32.94%) respectively followed by aural fullness 24 (28.23%) and ear ache (otalgia) 17 (20.0%) with warmth sensation in ear 13 (15.3%) the least presenting complaint. Subjects using mobile phones for 3-6 years 31 (36.47%) were in the maximum number followed by 28 (32.94%) who were mobile phone users for >6 years and 26(30.58%) using mobile phones for 1-3 years duration were in the least. Maximum number of

subjects 37 (43.52%) were using mobile phones for a stretch of 4-6hrs per day. Number of subjects using their right ear for telephonic conversation was 36 (42.35%) whereas those using left ear were 29 (34.11%). Hence the dominant ear in most of the subjects was right ear (Figure 1).



**Figure 1: Dominant ear in the study group.**

In current study, subjects using headsets sometimes for telephonic conversation were in the maximum number 33 (38.82%), always were 25 (29.41%), seldom were 16 (18.82%) and never were 11 (12.94%) as shown in (Figure 2).



**Figure 2: Usage of headset in the study group.**

Statistically significant  $p < 0.001$  was observed while comparing SNHL with hours of exposure and years of exposure. In subjects exposed to mobile phones for 2-4 hours per day for 1-3 years, 13 (15.29%) had normal hearing and none had mild/moderate SNHL. For patients who were using mobile phones for >6 hours/day for a stretch of (1-3), (3-6) and >6 years, statistically significant  $p = 0.005$  was observed while comparing with HL. Hearing loss is pure SNHL as we have already excluded conductive/ mixed hearing loss from our study (Table 1). Statistically significant  $p < 0.05$  was observed while comparing hours of exposure with tinnitus. Statistically significant  $p < 0.05$  was observed while comparing hours of exposure with both aural fullness and warmth sensation in ear (Table 2).

For patients who were using mobile phones for 2-4 hours/day for a stretch of (1-3), (3-6) and >6 years, observed  $p$

value was statistically significant (0.05) while comparing with tinnitus. Statistically insignificant  $p$  value was observed while comparing hours and years of exposure with other associated complaints like aural fullness, ear ache (otalgia) and warmth sensation in ear.

## DISCUSSION

The present study titled “mobile phones and its effect on hearing” was undertaken in Netaji Subhash Chandra Bose Subharti medical college & associated Chhatrapati hospital in patients who were mobile phone users in the age group of 18 to 45 years in both sexes, with the aim of studying the effects of mobile phones on hearing by evaluating them with the required questionnaire, taking detailed history and examination followed by pure tone audiometry and also to find the incidence of associated symptoms other than hearing loss. Due to the exponential growth in the number of mobile phone users, and also due to close proximity to the ear, there can be potential damage to auditory function.<sup>16</sup> Ill effects of electromagnetic radiations on humans are rightly assumed as the matter of serious public health concern. Therefore, any detrimental biological effect(s) related to mobile phone use should be considered as a high-priority health issue and a potential matter of scientific discussion.

In current study, female preponderance was observed. This is also similar with the study conducted by Das et al, Magda et al and Virachai et al in which there was female preponderance.<sup>17-19</sup> In current study which comprised of 85 subjects, 36 (42.4%) were right ear dominant and 29 (34.1%) were Left ear dominant and 20 (23.5%) had no preference. This is in accordance with the study conducted by Ramya et al and Seidman et al.<sup>20-21</sup>

In current study, it was observed that the duration of hours and years of exposure to mobile phones had significant impact on HL. Exposure to mobile phones for a stretch of 2-3 hours/day for 1-3, 3-6 and >6 years had significant SNHL and  $p$  value turns out to be statistically significant ( $p < 0.05$ ). Exposure to mobile phones for a stretch of 4-6 hours/day for 1-3, 3-6 and >6 years had significant impact on SNHL and  $p$  value turns out to be statistically significant ( $p = 0.05$ ). Exposure to mobile phones for a stretch of >6 hours/day for 1-3, 3-6 and >6 years had significant impact on SNHL and  $p$  value turns out to be statistically significant ( $p < 0.05$ ). Our study is in accordance with the study conducted by previous reports in which it was observed that mean HFHL (SNHL) was associated with long term usage of mobile phones with significant  $p < 0.05$ .<sup>20</sup> A similar study by Das et al also observed that in terms of hours and years of exposure to mobile phones, the hearing thresholds (bone conduction thresholds) were significantly higher in the exposed ears at all speech frequencies and  $p$  value was found to be statistically significant ( $p < 0.05$ ).<sup>17</sup>

**Table 1: Descriptive analysis of SNHL and hours as well as years of exposure (n=85).**

Duration (hours)	Years of exposure	PTA			Mean hearing loss (dB)	P value
		Normal	Mild SNHL	Moderate SNHL		
2-4	1-3	13	0	0	0	0.007*
	3-6	6	1	0	2.75	
	>6	3	4	0	4.02	
4-6	1-3	1	5	0	3.2	0.054*
	3-6	3	14	0	4.7	
	>6	2	12	0	7.85	
>6	1-3	3	4	0	8.01	0.005*
	3-6	0	7	0	10.94	
	>6	0	6	1	14.3	

\*statistically significant.

**Table 2: Descriptive analysis of associated complaints and hours and years of exposure (n=85).**

Duration (hours)	Years of exposure	Associate complaints			
		Tinnitus	Aural fullness	Earache (otalgia)	Warmth sensation in ear
2-4	1-3	6	1	2	4
	3-6	1	1	3	3
	>6	3	2	1	2
<b>P value</b>		0.046*	0.862	0.312	0.821
4-6	1-3	2	3	1	0
	3-6	4	7	1	2
	>6	6	5	5	0
<b>P value</b>		0.051	0.058	0.069	0.328
>6	1-3	3	2	2	2
	3-6	3	1	0	0
	>6	1	3	2	0
<b>P value</b>		0.054	0.497	0.291	0.110

\*statistically significant.

In current study, it was observed that number hours of exposure to mobile phones had significant impact on tinnitus, aural fullness and warmth sensation in ear, p value was found statistically significant with tinnitus, aural fullness and warmth sensation in ear. Current study is in accordance with the study conducted by Khan et al in which out of 11% of subjects using mobile phones for 1- 2 hours per day, 78% of them were having warmth sensation in ear. Out of 4.5% of the subjects using mobile phones for >2 hours per day, 84% were having warmth sensation in ear and findings were statistically significant.<sup>21,22</sup> Current study is also in accordance with the study conducted by Hegde et al in which out of 60 subjects who were exposed to mobile phones for various hours of duration, aural fullness and tinnitus were observed in 15% and 10% of the subjects respectively and p value was statistically significant with the symptoms at the time of presentation.<sup>23</sup>

While comparing both the parameters i.e. hours and years combined with associated symptoms, it was observed in our study that the duration of exposure in terms of both hours and years had significant impact on tinnitus presentation among subjects in the study. It did not have

much impact on other symptoms like aural fullness, ear ache (otalgia) and warmth sensation, p value was statistically significant for tinnitus (<0.05) and insignificant when it comes to other symptoms like aural fullness, ear ache (otalgia) and warmth sensation in ear. This is in accordance with the studies conducted by Hans et al and Magda et al in which tinnitus was observed in patients with exposure to mobile phones and p value was statistically significant.<sup>18,24</sup>

### Limitations

Limitation of the present study is its small sample size. Research is still on the way to study the various effects of the electromagnetic radiations by mobile phones and many studies have shown the harmful effects of the usage of mobile phones on human health. Further research with population based studies is necessary to draw or arrive at a precise conclusion.

### CONCLUSION

The present study shows an increase in the hearing threshold of the ear exposed to the prolonged use of



mobile phones. It is not known whether this threshold shift is temporary or permanent. Scientific data are lacking on the molecular and biochemical alterations caused by the EMRs in the inner ear. As such this area provides an interesting avenue for further research.

*Funding: No funding sources*

*Conflict of interest: None declared*

*Ethical approval: The study was approved by the Institutional Ethics Committee*

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**Cite this article as:** Swaroop K, Kumar S, Bansal A, Khare P, Chauhan DV, Rao N. Study of the effect of mobile phones on hearing. *Int J Otorhinolaryngol Head Neck Surg* 2021;7:520-4.