

# EFFECTS OF MOBILE TELEPHONES ON HEARING

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**Abstract-** The exposure to electromagnetic field emitted by mobile telephones is increasing rapidly worldwide that causes side effects, including thermal and non thermal side effects. Ear proximity to electromagnetic source may lead to greater damage and side effects, including hearing loss. This study was performed to assess the chronic effect of exposure to electromagnetic field of mobile telephones on hearing by audiometric measurements. A total of 200 subjects (100 users and 100 non-users) were studied, using historic cohort method. The subjects did not have history of any clinical condition possibly implicated in hearing loss, history of ear disease or pathology in otoscopic examination. Only the users dominant ears were studied (right side 75% and left side 25%). 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,  $+0.12 \pm 5.93\text{dB}$  and  $-3 \pm 4.73\text{dB}$ , respectively. Duration of use was also related to threshold changes. This investigation showed that mobile sets may cause increase of the pure ton threshold. We suggest further studies to find out potential hazards of using mobile telephones and to develop guidelines for the mobile telephone users.

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**Key words:** Mobile telephone, hearing loss, ear, hearing threshold, audiometry

## INTRODUCTION

Because of rapid increase in the use of mobile telephones, especially in developing countries (about one billion mobile phones by 2005), even a small effect on health could have major public health consequences (1-10). The amount of absorbed energy depends on both limit of exposure and distance from source. Since ear is the closest organ to mobile telephones and this may cause a higher energy deposition in the ear compared the other parts of the body, effects on hearing are debated (2).

In Iran, we had 2159871 mobile telephone lines by March 2002. This study was performed to assess the chronic effects of electromagnetic field on hearing by pure tone threshold audiometric screening.

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## MATERIALS AND METHODS

A total of 200 subjects, 100 of whom were mobile users (80% male and 20% female), with mean age of  $28 \pm 5.5$  (age range of 20-45) and 100 non-users with mean age of  $27 \pm 3.1$  (age range of 19-39 and the same sex ratio of users) voluntarily participated in this study.

Duration of use had to be at least one year. Only the users dominant ears were studied (right side 75% and left side 25%). In both groups, the excluding criteria were presence of clinical conditions possibly implicated in hearing loss (age, chronic diseases, e.g. diabetes mellitus, cardiovascular diseases, hyperlipidemia, exposure to acoustic trauma), history of hearing loss or other hearing problems. Otoscopic examination was performed by an otolaryngologist before testing to rule out ear pathology that could influence audiometric examination. Audiometric measurements were performed and audiologist determined pure-tone threshold for the octave and half octave with S.A.

77. The diagnoses of affected cases were based on normal history and otoscopic examination and audiometric measuring.

The data from users and non users of mobile telephones was compared statistically with *t* test and a *P* value < 0.05 was considered to be significant.

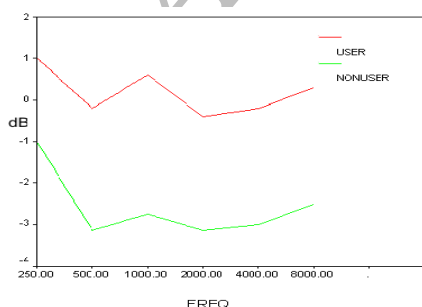
## RESULTS

Mean pure-tone thresholds (250 to 8000 HZ) in the users and non-users of mobile telephones were  $+0.12 \pm 5.93$  dB and  $-3 \pm 4.73$  dB, respectively, that showed a significant difference (*P* value < 0.01). Detectable response was found at all frequencies (500 to 8000 HZ) except at 250 HZ (Fig. 1).

Duration in using the mobile sets was from one year to five years with daily use from 10 min to 5 hours and the Nokia sets were the most commonly used mobile sets (44%) (Table 1). Duration of use was related to threshold changes *i.e.* the greater threshold increase was associated with the greater use (*P* < 0.05).

## DISCUSSION

Over the past two decades, there has been increasing interest in studying the biological effects and possibility of the health hazards of mobile telephones (11). Byrne and Burwood studied wireless telephones and hearing aids (12) and Oztran *et al.* studied effects of the electromagnetic fields of mobile telephones on hearing by otoacoustic emissions (2). In 1989, the Institute of Electrical and Electronic Engineers (IEEE) declared that there was not enough revealed scientific data of electromagnetic fields effects and mobile sets might be associated



**Fig. 1.** Distribution of pure-tone threshold in users and nonusers of mobile phones.

**Table 1.** Frequency of the mobile sets in this study

Mobile Set	Frequency
Nokia	44%
Samsung	28%
Sony	8%
Alkatel	6%
Sagel	6%
Erickson	4%
Siemens	4%

with health hazard. Therefore, there is a general agreement over the necessity of further research (11, 12).

Epidemiological studies showed that the use of mobile telephones were associated with some effects on human health (13). Exposure to electromagnetic fields emitted by mobile telephones use may lead to hazardous exposure effects after long and repeated exposure although short term exposure did not have any effects on body (14). The rate of absorption and distribution of electromagnetic fields energy in an organism depends on many factors, including the frequency of electromagnetic fields, dielectric composition of irradiated tissue (bone, with a lower water content, absorbs less energy than muscle), shape, geometry and orientation of the object and proximity of the source. There is evidence that the low intensity, pulsed radiation currently used can exert subtle non-thermal influences (15). Although pure-tone audiometric studies are less sensitive in measuring cochlear functions, the results of the present study, show that pure-tone threshold in users is different from nonusers; however, thresholds were in normal limits, perhaps the longer use could be associated with the greater lesions.

This study suggests guidelines for mobile telephone users: 1) short dialogue periods and use for essential purposes, 2) use of telephone with low electromagnetic fields emissions, 3) use of hands-free devices and other protective devices, and 4) audiological screening before using mobile sets. We also recommend investigation on larger samples and longer duration with more sensitive methods (*e.g.* high frequency audiometry and auditory brainstem response).

## Conflicts of Interests

We have no conflicts of interest.

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