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Environmental impacts of electromagnetic waves of mobile phones on human health

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ABSTRACT

Microwave radiation has multi-functions in different industrial, medical, scientific and house appliances. With a working frequency of about 1 GHz, their usage in mobile phones brings about thermal and non-thermal effects. Given the high and long-term usage of mobile phones by individuals and biologic effects related to field intensity, frequency, Waveform, and exposure duration, we are interested in doing some research in this area and studying the current related standards and shortfalls/shortcomings. The research, in fact, tries to review the related findings and current standards to find reasonable answers to solve the current conflicts in this area and provide a response to prosecutors specially those complaining about installing mobile communication masts. The previous studies on scientific findings indicate that protective concerns and standards based on ICNIRP instructions should be a priority in organizations and related organs.

Keywords: electromagnetic waves, environmental impacts, mobile phone, BTS masts, radio fields.

INTRODUCTION

Technology usage in advanced countries and importing it to advancing countries has brought about negative effects and consequences for its users. Of the technological outcomes is using electromagnetic waves in different industrial, medical, scientific and household appliances. Electromagnetic waves are radiation energy with wide spectrum which starts from 10 Hz and ends to 10^{21} Hz cosmic waves.

Microwaves are electromagnetic waves with frequency range of 300 MHz to 300 GHz and wave length of 1 mm to 1 m. The applications of microwaves in industry (weaving, plastics, papermaking, food conservation, carpentry, radar, radio and television stations, navigation waves, satellites, telephone and telegraph) and medicine (e.g. diathermy and heater machinery) has increased its importance. Microwaves with frequency band of 1 GHz in mobile phones as well as ever-increasing mobile users, has put the humankind to these waves. This research tries to review the related findings and current standards to find reasonable answers to solve the current conflicts in this area and

provide a response to prosecutors specially those complaining about installing mobile communication masts. The studies include:

Epidemiologic results, Swiss case: the results show a 74% complaints related with antennas. The findings in the area of exposure are as below:

✓ 49% sleeping disorder
✓ 17% headache
✓ Concentration disorder
✓ Exhaustion

In the final analysis, the questionnaire findings show that 74% of respondents believed that symptoms were the result of BTS antenna, 15% mobile phones, and 11% transmission lines. In either case, doing comprehensive researches on the exposure effects is necessary.

The maximum exposure occurs near the antenna and direct exposure to waves more than the safe limit determinate by ICNIRP. Distancing from the antenna to less than 4.8 meter, the power density decreases to less than the ICNIRP safe limit.

Saneini findings: the studies conducted in this area shows that the impacts on the inhabitants around mobile antennas, based on their distance from the antenna are categorized into three:

1. 100 meter: irritability, tendency toward depression, memory loss, anemia
2. 200 meter: headache, sleeping disorder, uneasiness, and skin problems
3. 300 meter: exhaustion

A study in Japan:
We need to note that exposure to mobile phone microwaves in metal boxes increases the energy absorption. Talking with mobile phones in the car, for example, increases the energy absorption which is probably the result of radiation of the waves through the metal surrounding and re-absorbing it by the body. Therefore, it is recommended either not to use mobile phones is these circumstances or to use small mobile bags to decrease waves absorbed by the body.

A study in Iran:
This study compares and contrasts the reference scopes and scales taken from regulations, standards, instructions and other national and international documents. The focal point, here, is frequency spectrum range (900 MHz) to cover measures in the locations around the major stations of 900 GSM. Among the 346 measured instances in a unit frequency in a 900 band GSM, for the general population, the maximum density was 13/4 mW/m^2 in 952.4 MHz equal to 28% of the ICNIRP safety limit. The maximum density in single frequencies of less than 1 µ and 13.4 mW/m was not definite (i.e. equal to a difference of 7 meaningful values).

Mobile phone networks and BTS masts
Antennas used in communication areas of mobile phones, DSL etc. are referred to as BTS antennas. BTSs have 3 sectors of A, B, and C each covering around 120 and totally 360 horizontal degrees. Each BTS supports about 30 Km. However, their practical range in open spaces, when there is no building or obstacle, is 20 Km. In urban spaces with many tall buildings, the practical range of BTS is estimated to be 2 to 5 kilometers. Output power of BTs and output power of the phone is regulated automatically; when staying adjacent to a BTS, the output power is less and, on the other hand, when you are far from the BTS, it is more powerful. The practical range, based on frequency and output power mobile phones is as below:

Inner city	2-4 kilometers
Outer city	5-10 kilometers
Open space	2-10 kilometers

The base mobile phone station is installed in different areas to support geographical areas. The telephone network includes the control chamber connected to the base station and the sent signals are more than about 20 Km.

Based on the distance from the source, the physical nature of the electromagnetic waves emitting from an antenna creates various conditions for the measurement. For example, three near, middle, and far fields are identified around an antenna. The elements of electric and electromagnetic field in the far field have a very close relation and measuring just one of them is enough. In the far field, however, due to the complex relations between electric and

electromagnetic fields as well as intervening active energy between the source and human body, it is better to determine the rate of exposure based on the special absorption rate (SAR).

Regarding the antenna performance, the signals depend upon the antenna dish direction; some specific space under the antenna is shadow mode and the wave power is less than the antenna petal range.

Electromagnetic waves and the environment

The environment (ecosystem) all living and non-living things that occur naturally on Earth. The environment is composed of sets of external physical factors and living things interacting with and affecting the growth and behavior of each other. Natural environment is the biologic and non-biologic (physical, chemical) factors affecting and being affected by the lives of living things.

Of the factors affecting the environment are physical factors including the electromagnetic waves emitted by communication masts. Since this technology is only recently used and we have no authentic proofs in this realm, we cannot definitely identify its impacts on the environment.

The antennas in the environment radiate waves constantly. This has long-term effects on the environment and requires investigating the impacts of radial and microwave frequencies on environment and includes people as well as animals and plants and trees near the antennas.

As the result of ever-increasing mobile phone users worldwide, the impacts of mobile phone radiation on human health has come into the focus of the researchers, many studies are conducted on the radiation impact on human beings and animals. The results, however, do not provide a justifiable evidence/finding.

Of responsibilities of Environmental Protection Agency is investigating the radiation impacts and designing communication mast installation instructions based on the standards and presenting evidences to prepare a healthy environment for human beings and animals. Therefore, it has conducted some academic projects in this regard to organize executive instructions.

Exposure standards of mobile phone radio fields

Below, we have used the authentic references including the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the World Health Organization (WHO).

Table1: radial local SAR in the frequency range of a mobile network (W/kg)

Radiation characteristics	Frequency range MHZ	Average body	Topical (head and body)
employees	900	0.4	10
Ordinary people	900	0.08	20

The environmental impacts in the frequency range of mobile networks occur when the body temperature raises 1^{oC}. This amount is equal to absorbing about 4 W/kg energy in the whole body as the result of getting exposured to the field width more than 30 minutes. Taking this amount into account, the base limit for a body SAR with protection coefficient of 0.1, is assumed 4.0 W/kg. For ordinary people, this value is limited to the protection coefficient of 1.5 and 8.0 W/kg.

Table2: ICNIRP standard base limit for power density in 10 to 300 GHz frequencies

Exposure characteristics	power density (watt per square meter)
employees	50
Ordinary people	10

The results of scientific researches show thermal impacts as the foremost factor for showing the guide regarding the exposure to the remaining radiation. The solution is provided to the NRPB (National Radiation Protection Bureau) through ICNIRP. But for now, findings show that exposure to radio fields in lower levels than what has been set by NRPB ICNIRP, has no negative effect on people's health.

The tables below compare the electric field and power density standards of radio-frequency fields of mobile phones in different countries.

Table3: Mobile radial field exposure standards in 900 MHz frequency

Mobile Radiation limit in 900 MHz	electric field intensity (V/m)	power density (W/m^2)	type
(ICNIRP) International Commission on Non-Ionizing Radiation Protection	41.25	4.5	guideline
and American National The Institute of Electrical and Electronics Engineers Standards Institute (IEEE/ANSI)	47.6	6	standard
(CENELEC)European Committee for Electro-technical Standardization	41.1	4.5	standard
(AS/NSZ) Australia	27.5	2	standard
(ONORM) Austria	47.6	6	Pre-standard
Hungary	6.1	0.1	standard
Italy	6	0.1	instruction
(NISV) Swiss	4	0.004	regulation
(NEL)Norway	49.1	6.4	report
(NRPB) England	112.5	33.2	report
(DOB) US Department of Defense	47.6	6	instruction
(FCC) Federal Communications Commission	-	6	standard
(safety code6)Canada	48.48	6	standard
Germany	41.25	-	instruction
Japan	47.55	3	standard
	-	10	standard

Current Standards and Regulations in Iran

✓Preventing Air Pollution Act (approved 23 April 1995) by the Council of Ministers: article 2- Any action leading to air pollution is forbidden. Air pollution is referred to emitting one or more solid, liquid or gas pollutant, radioactive and non-radioactive radiation to the amount which is harmful to human beings and other living things, plants and buildings.

✓Protecting and Improving the Environment Act (approved 18 June 1974 revised on 15 November 1992) the Council of Ministers: Article 9- Any act leading in environment pollution is forbidden. Polluting here is referred to emitting to or mixing any external material with water, air or ground to the amount that its physical, chemical or biological quality might be harmful to human or any other beings including plants and buildings.

✓Exposure limit, non-ionizing radiations (Iran Institute of Standard and Industrial Researches) including the exposure limits for electromagnetic waves of ELF, VLF, LE, RF and MW in work environments and popular places. Frequency range, electric field intensity limit, magnetic field intensity limit, density limit of the magnetic flux, and intensity limit for flat waves is shown in the table.

✓The agreement between Department of Agricultural Jihad and EPA for providing the location for BTS stations (in forest environments with power supply facilities, forest environments without power supply facilities, rural environments, rails, roads and other areas) according to the executive act number 3556T/35337 approved on 27 June 2008.

✓Determining the installation code of communication masts (BTS antennas) based on decisions taken in the investigation committee meeting on 11 May 2009. Determining the installation code for machinery and service units of group A (A-11), and service centers (the code is temporarily presented by Department of Health, Treatment and Medical Training, and Department of Nuclear Energy).

CONCLUSION

The results of analyzing the findings indicate that:

- No doubt, using mobile phones require infrastructures most important of which are BTS antennas.
- There are many researches being conducted on mobile phone impacts, and their findings show that field intensity surrounding mobile phone is very low.
- Despite the thermal impacts of microwaves which are exclusively defined by SAR, the biologic non-thermal impacts of microwaves depend on the exposure circumstances. In addition to power density and SAR, many different variables such as frequency, modulation, frequency and exposure duration, antenna distance to the context and the context area being exposed is also important. Density impact, however, is of more importance. Density impact is highly dependent on the exposure duration to the extent that non-thermal impacts resulting from low-density in long exposure can have similar impacts to the non-thermal impacts resulting from high power density in short exposure.
- Electrowave pollution is different from other pollution types and the conditions of a given area do not affect other areas. That is, an area is safe from wave pollutions of other areas, if the safety instructions are held.

To overcome the national problems, we need to plan installation instructions and application conditions of this section including installation regulations for BTS antennas. In this regard, the related institutions should cooperate to transfer the required information to conduct and guide the executing projects.

In addition, the responsible institutions should inform the results and findings of field activities to reach regulations and standards. One of the shortcomings resulted from the lack of cooperation between the responsible organizations is non-responsiveness to the communications with the related institutions. Other shortcomings include unauthentic reports regarding side-effects of communication antennas, while no international organization has either reported or approved side-effects for using mobile phones.

Suggestions

Healthy mobile phone usage in alignment with the current guidelines requires less risky and more green solutions. Devising administrative standards with an eye on environmental health issues also needs to be prioritized. We can minimize the possible side-effects of powerful radiations through informing the people about harmful positions of EMF producer units. However, for more sensitive parts of the society, including children, the elderly, health centers, pregnant women etc, we need to devise special considerations.

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