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Assessment of Health Effects of Cell-phone Towers Radiation in Najaf on Human Beings

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Abstract. A survey was conducted to collect information on possible health risks of cell-phone towers in Najaf Governorate, Iraq. Data were obtained from people living near to cell-phone towers. A questionnaire was used to collect information from 600 people and included 20 potentially unspecified health symptoms. In addition to measuring the power density of nearby sites around the towers within a distance of 100 meters. Results of the data analysis indicated that people who live near mobile phone towers within a range of 50 meters and for a long period of time are exposed to some potential health risks., such as (A decline in general health, Fatigue, Headaches, Muscle pain, Nausea), Females are more exposed to these risks than males. The measurement of power density inside homes was within the safe limit recommended by ICNIRP and Bio initiative Report.

Keywords. Cell-phone towers, electromagnetic radiation, health effects, Najaf, Iraq.

INTRODUCTION

Electromagnetic radiation travels in space at the speed of light and consists of magnetic and electrical waves [1]. Electromagnetic radiation is a vital necessity for human existence such as air. These radiations are found everywhere in the universe. Radiations emits from the things we use in our daily lives, such as computers, laptops, microwaves, mobile phones, X-rays, etc. These devices have become a needful part of our lives [2].

Electromagnetic radiation is defined as a stream of photons in space. These photons possess an amount of energy and according to this amount of energy. Electromagnetic radiation is divided into two types: the first is ionizing radiation, which has enough energy to overcome the energy of the bonding of electrons to atoms or molecules and thus the formation of ions, including ultraviolet, X-ray, gamma and cosmic rays. The second is non-ionizing radiation, which does not have enough energy to ionize atoms or molecules such as low-frequency radiation like radio and infrared [3].

The use of high-frequency mobile phones is widespread in our society recently. These phones are everywhere and are used today by more than 1.5 billion people in the world and this number is increasing [4].

Wireless mobile technology relies on large networks of base stations that use radio frequencies to connect users. The potential health consequences of human exposure to radio frequencies in general and radiation from base stations in particular have caused considerable concern [5-7].

There are four main frequencies of electromagnetic waves used in mobile phone communications (800,900,1800,2450) MHz, known as mobile phone frequencies. Common technologies in the global communications system are GSM800, GSM900, GSM1800, and GSM2450 [4, 8].

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In Iraq in general and Najaf province, especially the use of communication technologies GSM900, GSM1800 is the most common, where mobile phone towers are spread everywhere in the villages and cities in our country.

It is believed that there is energy of non-ionizing radio-frequency radiation emitted due to mobile phones sufficient to heat the tissues of the body, and is likely not to have the same effect of ionizing radiation on human health as those from X-rays [9]. However, there is an urgent need to know and determine the level of health risks from Wireless radiations. Many scientists and researchers around the world have studied the risks and harmful effects of radiation used in mobile communications on human health and organisms [10-15]. Much of this research studies the effects of mobile phone radiation on the human body, while few are interested in the impact of human exposure to earth station radiation, although the effect here is greater as the entire body can absorb radio-wave energy [6].

In May 2011, the International Agency for Research on Cancer (IARC) classified the radiofrequency band as possibly a human carcinogen (Group 2B) based on an increased risk of glioma, a malignant type of brain cancer associated with wireless telephone use [16]. Some biochemical parameters for evaluating the effects of electromagnetic waves from cell phone towers on humans have been completed. Four Iraqi governorates were selected: Basra, Dhi Qar, Maysan, and Najaf. (400) blood samples were collected from volunteers. 100 samples from each province of men aged 30–40 years. Among those who lived in the same house for at least a year, approximately-not more than 200 meters away from mobile phone towers and from various In these regions, biochemical results showed an increase in serum cholesterol (TSCH), triglycerides (TGs), low-density lipoprotein (LDL), low-density lipoprotein (VLDL), aminotransferase (AST, ALT), and blood calcium (Ca++) where there was a significant increase in high-density lipoprotein (HDL) Except for the Maysan governorate[17]. The basic operation of cellular networks requires extensive human exposure to radio frequency (RF) radiation, with cellular base stations providing cellular coverage in most areas. Both base station density and power output are expected to increase global exposure to human RFR. Although the direct causation of the negative human health effects of RFR from cell phone stations has not been finalized, there is already sufficient medical and scientific evidence to justify long-term liability concerns for companies deploying cell phone towers. The effects of positioning are closely examined and recommendations are made to the companies that publish them to reduce their potential future liability[18]. Study the negative effects of Wi-Fi routers in homes on human health. They have been widely used for communications and the Internet. No home can do without it. The radiation emitted by these routers causes many symptoms, such as heart disease, sleep disorders, brain tumors, ear hearing problems, male infertility, etc. This study looked at 15 different symptoms that may be caused by radiation emitted by routers. A questionnaire was distributed to a large number of doctors working in five major hospitals in the city of Najaf, and another to individuals who have routers in their homes and those who do not have routers. The results showed that Wi-Fi routers have an impact on human health of no more than 30%. While routers have a greater impact on women than on men [19].

The aim of this study is to determine the safe extent of human habitation near phone towers for the purpose of reducing diseases that may be related to near or far from phone towers.

MATERIALS AND METHODS

Cell-phone towers were installed in the Najaf city (32°01′44″N 44°20′23″E), Iraq, after April 2003, and this study was carried out in 2019, which means that the residents of this city have been exposed to radio frequency (RF) for more than 16 years.

Questionnaire

A questionnaire was conducted on 20 different symptoms that people living near cell-phone towers within the range of 100 meters could have or suffer from. In order to study the health risks to which this population is exposed. The survey was conducted on 143 different houses surrounding a number of towers distributed in different areas of the city of Najaf, the questionnaire included 600 adults (234 females and 366 males). Determine the level of complaints about symptoms using the following scale (0: no, 1: sometimes, 2: oftentimes, 3: often a lot), the health risks of residents of two groups were analyzed according to the distance range (less than 50 meters and more than 50

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meters). The questionnaires were divided into two groups, the first is for residents near the towers within a distance of less than 50 meters, and the second is for residents within a distance between 50-100 meters.

The percentages of the questionnaire scales, which are (0: no, 1: sometimes, 2: oftentimes, 3: often a lot), have been calculated for all symptoms. Table 1 represents the percentages of different questionnaire scales for males and females who live within the range less than 50 meters, where scale 3 and 2 can be considered more reliable to judge because it is Symptoms represent the most inherent to people.

Frequency Spectrum and Power Density

The device EXTECH (RF EMF strength meter) model 480836, manufactured by AFLR company, USA, was used to measure the frequency and power of cell phone towers. This instrument is able to measure the frequencies of non-ionizing radiation within a range of 50 MHz to 3.5 GHz. Other electromagnetic signals were measured in most regions, which were found to be due to the radio and television frequencies because they are outside the GSM900 frequency range. Taking into account the absence of any turned on mobile device and the value of background radiation (-55 dB), the power density has been measured in many houses near the cell-phone towers. The main objective of this procedure is to ensure that the radio frequency emitted from cell-phone towers does not exceed the safe public limits, and also to find any relationship that can link the power density and the health of populations.

The RF power density $\mathcal{P}_d$ can be written as [20].

$$\mathcal{P}_d = \frac{n\mathcal{P}_t G}{4\pi \mathcal{D}^2}$$

Where n: Number of transmitters, G: Gain of antenna (in dB), $\mathcal{P}_t$: Maximum power for each transmitter, $\mathcal{D}$: Distance between the transmitter and measurement site. The measurement of power density was done by the instrument EXTECH (RF EMF strength meter).

RESULTS AND DISCUSSIONS

Females suffer more than males in many symptoms, in scale (3: often a lot) we see that females have a relatively higher percentage in 13 of the symptoms which is (A decline in general health, Anxiety and alarming nature, Birth deformities, Cardiac disorders/Blood Pressure, Difficulty in concentration, Fatigue, Headaches, impaired immune system, Memory loss, Muscle pain, Nausea, Sleep disorders, Vision problems), while males have relatively higher percentages in 7 of the symptoms which are (Change in blood count/Blood sugar levels, Dizziness, Feeling of discomfort, Hearing problems, Infertility, Respiratory Disorders, Skin Problems), as shown in Figure 1. Where the Figure 1-(a) represents the comparison between the percentages of males and females within the scale (33: often a lot) of the questionnaire.

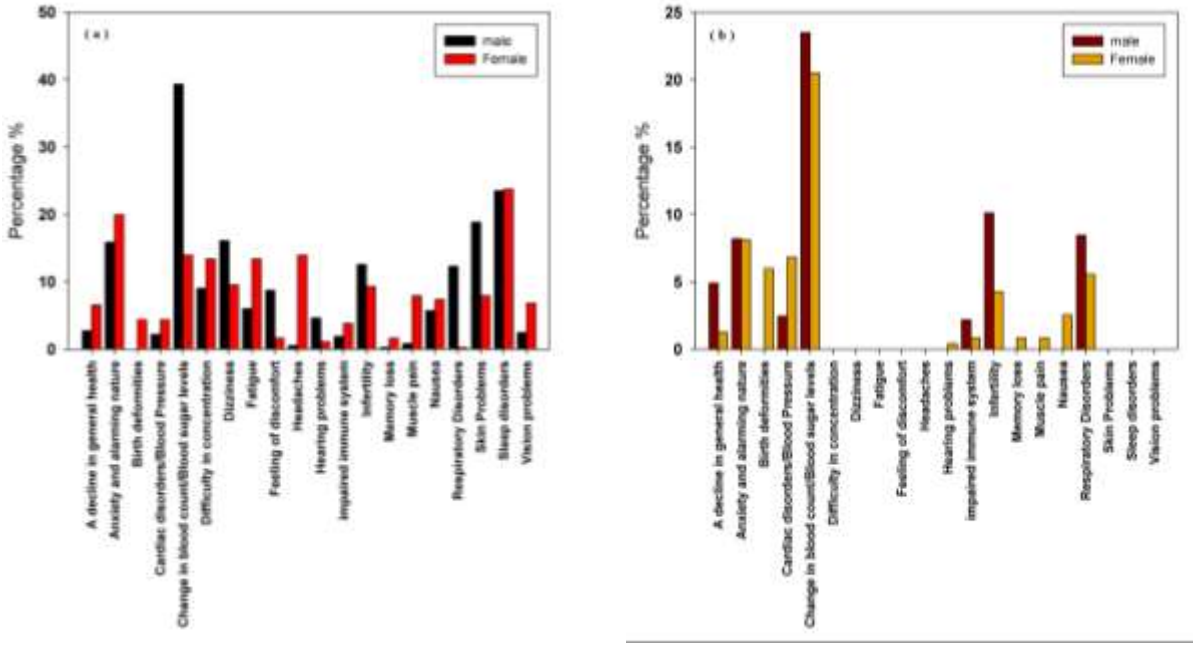
We can explain the increase in the percentages of females compared to males to the presence of females in the house for a long period of time, where most women spend a lot of their time at house, which makes them exposed to radio frequencies (RF) emitted from nearby towers for longer periods of time than males, for this reason perhaps these symptoms increase in females.

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TABLE 1. The percentages of male and female questionnaire for the four scales of residents within the range are less than 50 meters.

Symptoms	Percentage %							
	0: NO		1: sometimes		2: oftentimes		3: often a lot	
	M	F	M	F	M	F	M	F
A decline in general health	58.74	48.09	31.42	36.34	7.10	9.02	2.73	6.56
Anxiety and alarming nature	39.07	33.61	31.42	34.15	13.66	12.30	15.85	19.95
Birth deformities	100.0	95.63	0.00	0.00	0.00	0.00	0.00	4.37
Cardiac disorders/Blood Pressure	50.00	59.56	42.62	32.51	5.19	3.55	2.19	4.37
Change in blood count/Blood sugar levels	54.64	55.46	0.27	13.39	5.74	17.21	39.34	13.93
Difficulty in concentration	31.42	30.33	42.35	45.63	17.21	10.66	9.02	13.39
Dizziness	41.80	26.50	33.61	53.28	8.47	10.66	16.12	9.56
Fatigue	38.25	37.16	51.64	39.89	4.10	9.56	6.01	13.39
Feeling of discomfort	65.57	50.55	16.39	32.79	9.30	15.03	8.74	1.64
Headaches	43.72	37.70	49.18	40.71	6.56	7.65	0.55	13.93
Hearing problems	69.67	63.39	17.21	25.96	8.47	9.56	4.64	1.09
impaired immune system	72.13	67.21	19.40	27.05	6.56	1.91	1.91	3.83
Infertility	87.43	90.71	0.00	0.00	0.00	0.00	12.57	9.29
Memory loss	54.92	51.91	40.98	45.63	3.83	0.82	0.27	1.64
Muscle pain	47.27	43.44	44.81	38.52	7.10	10.11	0.82	7.92
Nausea	50.00	40.44	34.70	42.08	9.56	10.11	5.74	7.38
Respiratory Disorders	60.38	67.21	15.30	27.87	12.02	4.64	12.30	0.27
Skin Problems	29.51	37.43	36.34	34.15	15.30	20.49	18.85	7.92
Sleep disorders	39.07	36.89	19.95	28.69	17.49	10.66	23.50	23.77
Vision problems	50.82	45.08	29.51	40.16	17.21	7.92	2.46	6.83

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(a) **(b)**

FIGURE 1. Comparison between the percentages of males and females of scale (3: often a lot) for residents (a) less than 50m (b) greater than 50m**.**

In scale (2: oftentimes), we can also note that females suffer relatively more than males, where females have higher percentages of males in ten symptoms (A decline in general health, Change in blood count/Blood sugar levels, Dizziness, Fatigue, Feeling of discomfort, Headaches, Hearing problems, Muscle pain, Nausea, Skin Problems), while males have higher percentages in eight symptoms (Anxiety and alarming nature, Cardiac disorders/Blood Pressure, Difficulty in concentration, impaired immune system, Memory loss, Respiratory Disorders, Sleep disorders, Vision problems).The long period of time that females spend in house is the main reason for increasing their symptoms. The questionnaire indicated that the common symptoms that women suffer from, which that have the highest percentages in scale 2 and 3 are (A decline in general health, Fatigue, Headaches, Muscle pain, Nausea). While the only common symptom experienced by males is (Respiratory Disorders) and it is probably because of smoking because most of the males in this study are smokers.

Table 2 represents the percentages of different questionnaire scales for males and females who live within the range greater than 50 meters, From Table .2 we can clearly notice that many symptoms did not record any percentages according to scale 3 among males and females, or few percentages were recorded compared to the percentages recorded by residents within the 50-meter range (see Figure 1 (b)). We may not be able to confirm that radio frequencies are the only and main cause of these symptoms. However, through these questionnaires, we can confirm that these radio frequencies are an important factor in the appearance of these symptoms in the inhabitants.

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TABLE 2. The percentages of male and female questionnaire for the four scales of residents within the range are greater than 50 meters.

Symptoms	Percentage %							
	0: NO		1: sometimes		2: oftentimes		3: often a lot	
	M	F	M	F	M	F	M	F
A decline in general health	65.30	67.95	20.77	25.21	9.02	5.56	4.92	1.28
Anxiety and alarming nature	54.64	52.56	25.41	33.76	11.75	5.56	8.20	8.12
Birth deformities	100.00	94.02	0.00	0.00	0.00	0.00	0.00	5.98
Cardiac disorders/Blood Pressure	56.56	51.71	27.60	26.92	13.39	14.53	2.46	6.84
Change in blood count/Blood sugar levels	57.92	53.42	12.30	15.38	6.28	10.68	23.50	20.51
Difficulty in concentration	64.21	82.48	29.23	16.24	6.56	1.28	0.00	0.00
Dizziness	63.66	95.73	23.77	4.27	12.57	0.00	0.00	0.00
Fatigue	80.05	66.67	17.76	23.93	2.19	9.40	0.00	0.00
Feeling of discomfort	68.58	86.75	29.78	13.25	1.64	0.00	0.00	0.00
Headaches	59.02	89.32	31.42	0.00	9.56	10.68	0.00	0.00
Hearing problems	69.95	72.22	23.77	27.35	6.28	0.00	0.00	0.43
impaired immune system	78.69	70.94	13.66	21.37	5.46	6.84	2.19	0.85
Infertility	89.89	95.73	0.00	0.00	0.00	0.00	10.11	4.27
Memory loss	81.97	74.79	12.57	19.66	5.46	4.70	0.00	0.85
Muscle pain	54.92	65.81	30.87	21.37	14.21	11.97	0.00	0.85
Nausea	69.40	78.21	22.68	19.23	7.92	0.00	0.00	2.56
Respiratory Disorders	69.67	61.11	17.21	26.07	4.64	7.26	8.47	5.56
Skin Problems	68.03	63.68	20.77	31.20	11.20	5.13	0.00	0.00
Sleep disorders	52.46	74.36	35.25	19.23	12.30	6.41	0.00	0.00
Vision problems	48.09	78.21	36.89	20.51	15.03	1.28	0.00	0.00

We can discuss the great effect of radio frequencies emitted by mobile towers on the residents near them by studying scale 0 and 3, The percentages of no symptoms represented by scale 0 and their continued presence represented by scale 3 are a good basis for comparison. Where through comparison we can see the effect of the distance from the cell-phone towers on the appearance and disappearance of symptoms in males and females, respectively (as shown in Figure 3 and 2). From the figures, we can easily see the amount of symptoms being reduced when living far from the cell-phone towers.

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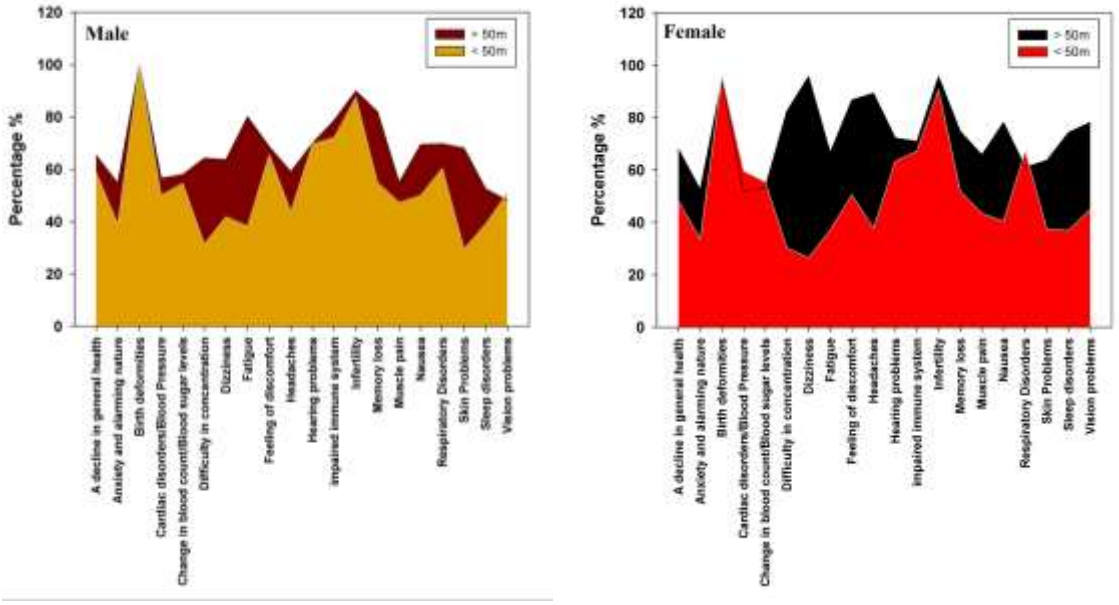
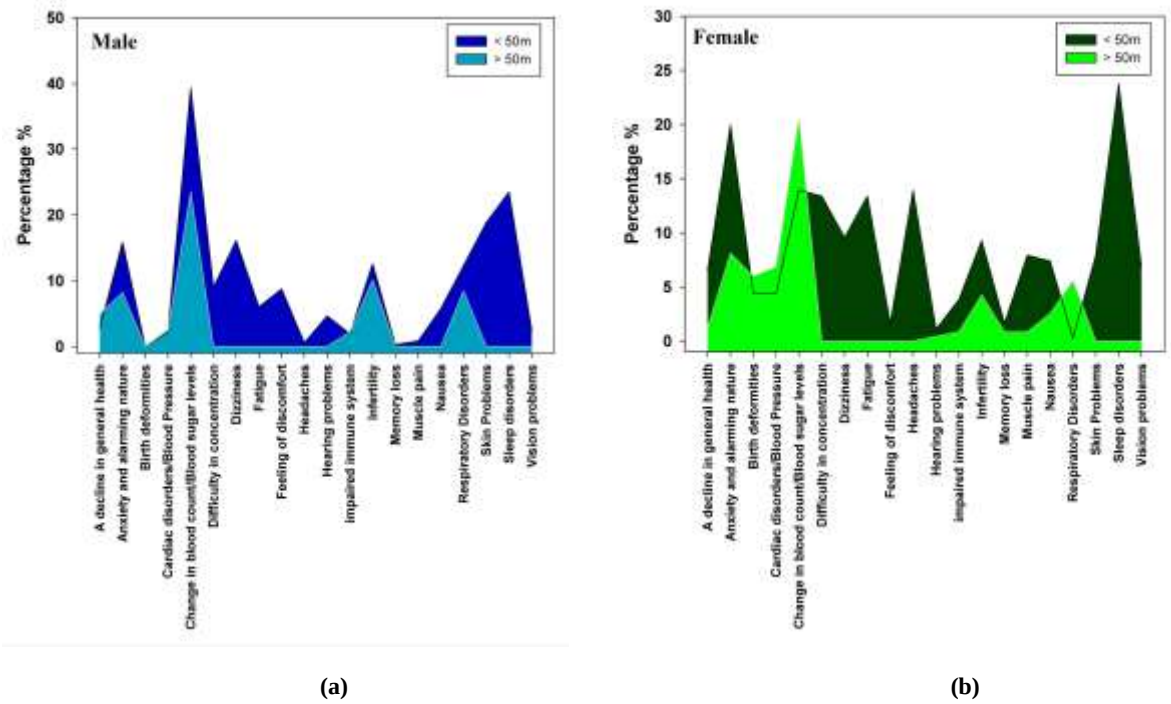


FIGURE 2. Comparison between the percentages of scale 0 at distance >50 and <50 meter for male and female.



(a) **(b)**

FIGURE 3. Comparison between the percentages of scale 3 at distance >50 and <50 meter for male and female.

The radio frequency (RF) absolute power density has been measured in different selected houses. These houses are located at different distances from cell-phone towers, not exceeding 100 meters. The area surrounding the tower was divided into zones (Zone A, Zone B, Zone C, Zone D, Zone E, Zone F) with specific ranges (15-25, 25-35, 35-50, 50-65, 65-80, 80-100) meter respectively, and the bedroom, living room, kitchen and the balcony in each house were chosen as a location for measurement. In all houses where the power density was measured, the type of

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building was Reinforced Concrete Construction (RCC). Where the type of construction is one of the effective factors that contribute to reducing the power density received by the residents [21].

Table 3 shows the measured power density rates within the zones identified. Where these rates represent the average readings measured within this region. The highest average value calculated in zone B and its amount (23.31 mW/m^2). While the lowest average values were calculated in the zone F and its magnitude (0.53 mW/m^2).As compared to the safe limit recommended by Bioinitiative Report (5300 mW/m^2) [22], and International Commission on Non-Ionizing Radiation Protection (ICNIRP) (4700 mW/m^2) [21], all values and rates were significantly lower. The height of the houses and the approaching with each other in addition to the furniture and the area of the windows played a big role in reducing the amount of power density measured inside the house.

TABLE 3. The average values of power density measured I different zones and the percentages with respect to recommended safe limits.

No.	Zone code	Distance range (m)	Measurement site	Average Power desity (mW/m^2)	% w.r.t Bioinitiative Report	% w.r.t ICNIRP
1	Zone A	15-25	Living room Bed room Kitchen Balcony	12.24	0.23	0.26
2	Zone B	25-35		23.31	0.44	0.50
3	Zone C	35-50		3.24	0.06	0.07
4	Zone D	50-65		2.01	0.04	0.04
5	Zone E	65-80		1.51	0.03	0.03
6	Zone F	80-100		0.53	0.01	0.01

CONCLUSION

We can conclude from the results of the questionnaire that many residents have different health complaints after installing cell-phone towers after 2003.We also noted that females have more health complaints than males, and that residents who live within the 50-meter range around cell-phone towers have more symptoms than those outside this range. The measured power density was large than the safe limit recommended by ICNIRP and Bioinitiative Report. Finally, we can recommend that cell-phone towers should not be installed inside residential areas, and we suggest avoiding people living within 50 meters of the tower.

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