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Assessment of Non-Ionizing Radiation Emissions from Cell Phone Towers

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ABSTRACT

People's growing anxiety, and fear of the issue of a large number of mobile phone towers, as well as the lack of studies dealing with this issue at the level of the country in general, and the governorate in particular. All these reasons led to the issue of non-ionizing rays given off by mobile telephone masts on the table of worries about how this radioactivity will affect people's health. Non-ionized radiation emissions were measured by taking 280 readings for the three frequency packets 900, 1800, and 1840 MHz, which are sequential-Global System Mobile (GSM), of 20 cell phone towers in the Al-Amara, the city center of Misan prefecture. Four readings were collected for each frequency, with the highest value for overlap between electromagnetic field and frequency being chosen. A selective Radiation Meter (SRM-3006) was the device used in this study. It was found that the amount of non-ionizing radiation emitted by the towers taken in the study, and for the frequencies (900, 1800, and 1840 MHz) was, in a successive manner (309×10^{-8}, 7×10^{-8}, and 1109×10^{-7} MHz). Thus, the measured values of radiation were less than the surveyed limit (4×10^{-1} µW/cm2) provided for by the law of Iraq's Determinants for Non-ionized Radiation Emissions (IDNREs).

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INTRODUCTION

In our modern culture, information, and communication technology are changing dramatically. As the prevalence of wireless communications devices increased, with approximately 5 billion mobile phone users worldwide, the World Health Organization (WHO) noticed the detrimental impacts of electromagnetic (EM) radiation revealed by cellphone towers and gadgets as a cancerous concern to human health on May 31, 2011. However, due to high demand, the total amount of cell phones in Iraq has surpassed 14 million. As a result, plenty of transmission tower bases have been created. As a result, there is growing worry about electromagnetic radiation being transmitted to humans and having biological consequences. (Al-Tamer & Al-Ahmady; Döken & Kartal, 2016; Gherardini, Ciuti, Tognarelli, & Cinti, 2014; Hussain, Ali, Mazhir, & Juma, 2014; Källander et al., 2013; Kaur, Kaur, & Sandhu, 2016; Rasheed, 2020; ŞAHİN, Nilüfer, & Karan, 2013).

From 1995 to 2013, a few systematic studies looked at the connection between mobile phone use and some diseases, such as skin diseases, as well as the repercussions of these applications through their effects on human behavior and health, such as normal human neurological

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functioning, taking sentiments (such as depression and anxiety) and cognitive abilities, such as executive control and working memory, into account. As a result of these concerns, the utilization of mobile applications has increased significantly, potentially increasing the risk of brain tumors.

These repercussions were additionally considered for children and adolescents. Additionally, the consequences of electromagnetic waves (EMW) duration of exposure have been reported linked to an increase in glioma and pituitary tumors. In addition, both positron emission tomography and Raman spectroscopy were performed with electromagnetic frequencies ranging from 900 to 1800 MHz Cellphone Electromagnetic Fields (MPEMFs) may affect brain activity and contribute to exposed red blood cells.

Furthermore, several types of research have indicated that the widespread use of cellular phones pollutes the environment with hazardous electromagnetic waves, such as generating a strong mutation in animal tissues.

While existing literature studies lack evidence of the strong biochemical impacts of electromagnetic waves on plants, such research motivates the investigation of the biological implications of electromagnetic radiation exposure on plants. Although existing literature studies lack evidence of the strong biochemical impacts of electromagnetic waves on plants, such research incentive the investigation of the biological implications of electromagnetic radiation exposure on plants. notably, plants cultivated near communication base stations. (Akakin et al., 2021; Bauer et al., 2019; Bhargav, Varambally, & Gangadhar, 2015; Chowdhury et al., 2021; Gupta, Sharma, & Singh, 2022; Hardell, 2018; Hardell, Carlberg, & Mild, 2013; Keykhosravi, Neamatshahi, Mahmoodi, & Navipour, 2018; Leng & Zhang, 2016; Li et al., 2021; Upadhyaya, Upadhyaya, & Patel, 2022a, 2022b; Yang et al., 2017)

The Global System for Mobile Communications (GSM) frequency band is between 890 and 960 MHz, there are two groups of frequencies: the frequencies between 890 and 915 MHz are utilized for transmission while the frequencies between 935 and 960 MHz are used for downlink as shown in Table 1. In Iraq, three major cellular mobile telecommunications networks are operational: Asia Cell, Korek, and Zain (Kaur et al., 2016; Salih, Saeed, & Saber, 2019)**.**

Furthermore, the mechanism of its dissemination in general, as well as its prevalence in our daily lives as a continually and/or frequently expelled product, have contributed to a focus on comprehending this proportion, and an experimental method has been employed to assess the process's most ideal and significant condition(Abdelzaher & Shehata, 2022; Elkhouly, Abdelzaher, & El-Kattan, 2021; Owaid, Hamdoon, Matti, Saleh, & Abdelzaher, 2022)

With this context in mind, in additionally, the scarcity of studies in the country in general and in the province of Maysan in particular the purpose of this study is to highlight the influence of non-ionizing radiation released by mobile towers* using 280 data from 20 towers in Al-Amara, the prefectural capital of Misan. Via Frequencies that have been measured were 900, 1800, and 1840 MHz respectively. Choosing the highest peaks of the frequency and electromagnetic field interference peaks and contrasting them with (IDNREs) by collecting four readings for each frequency.

Table 1. shows the frequency spectra of Iraqi telecommunications companies.

System	Frequency		Bandwidth
	Uplink	Downlink	
GSM	890-915	935-960	25 MHz
GSM 1800	1710-1785	1805-1880	75 MHz
GSM 1900	1850-1910	1930-1990	60 MHz
Korek	880.2-891.8	925.2-936.8	11.6 MHz
Zain	891.8-903.4	936.8-948.4	11.6 MHz
Asia cell	903.4 -915	948.4-960	11.6 MHz

* Because of the challenging circumstances brought about by the coronavirus epidemic, activity had to be restricted to this number

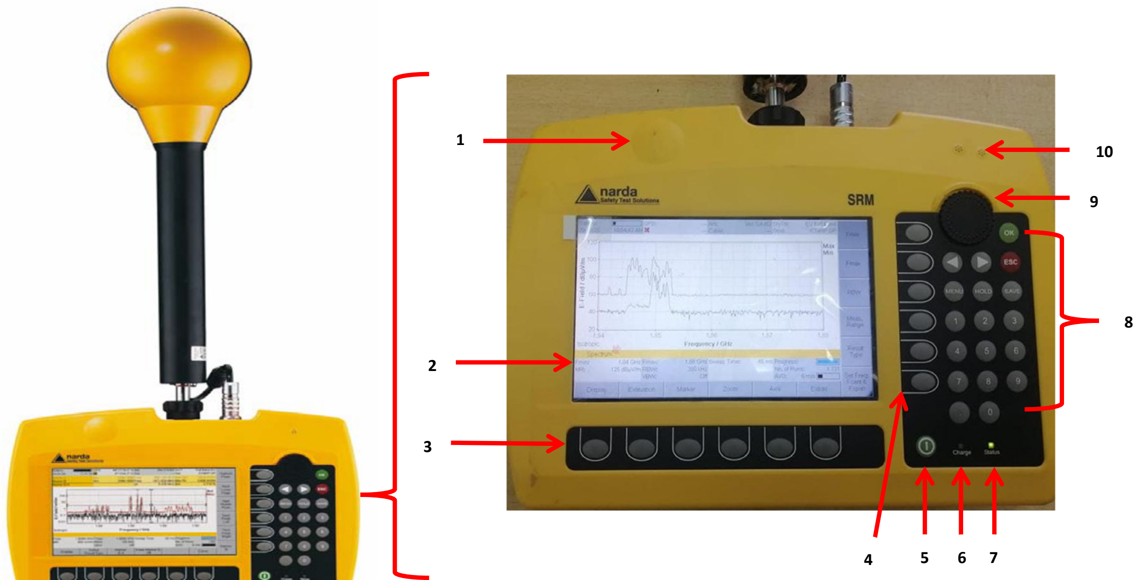
MATERIALS AND METHODS

Instrumentation

is an adjustable frequency Selective Radiation Meter instrument Figure (1a, 1b) for measuring safety and ambiance in high-frequency electromagnetic environments that span 9 kHz to 6 GHz.

Methods

This segment was completed in three stages: The initial stage has chosen 20 cellphone mobile towers* in Misan Governorate's Al-Amara city core of the processor Figure (2). In the



1. Global Position System (GPS) receiver, **2.** LCD panel, **3.** Horizontal soft keys, **4.** Vertical Soft keys, **5.** On/Off key, **6.** Charging indicator, **7.** Status display, **8.** Keypad and rotary control, **9.** Selects functions and values,**10.** Microphone

Fig. 1. Selective Radiation Meter SRM-3006 (on the left) and the components of the device (on the right)

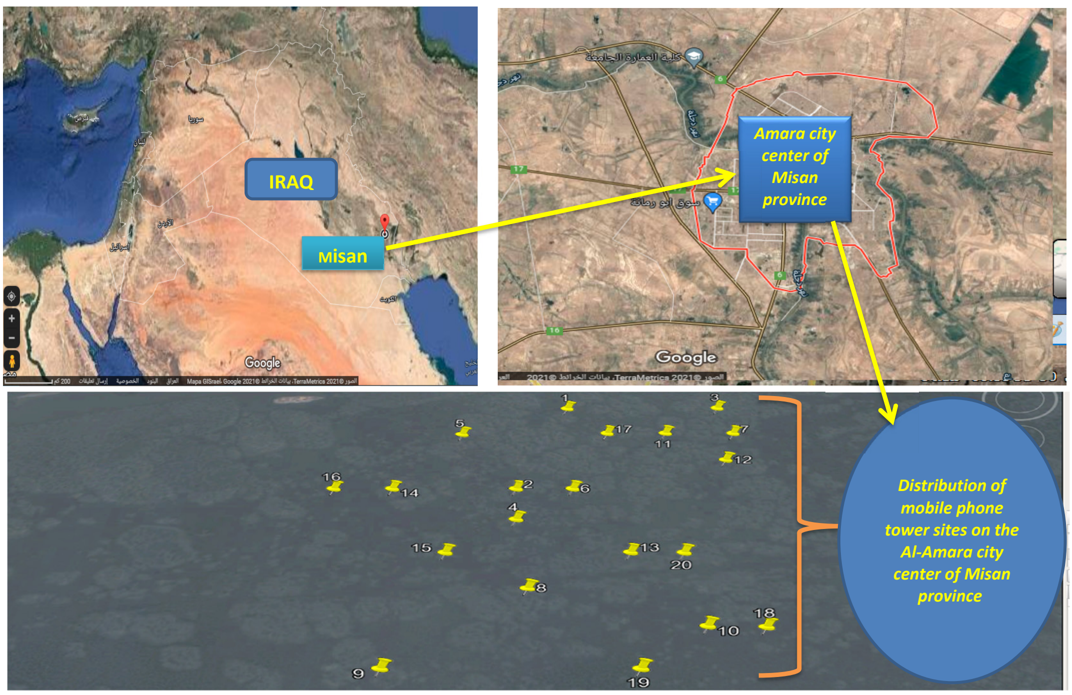


Fig. 2. The locations of 20 verified cellphone towers in Amara, Misan province's city center

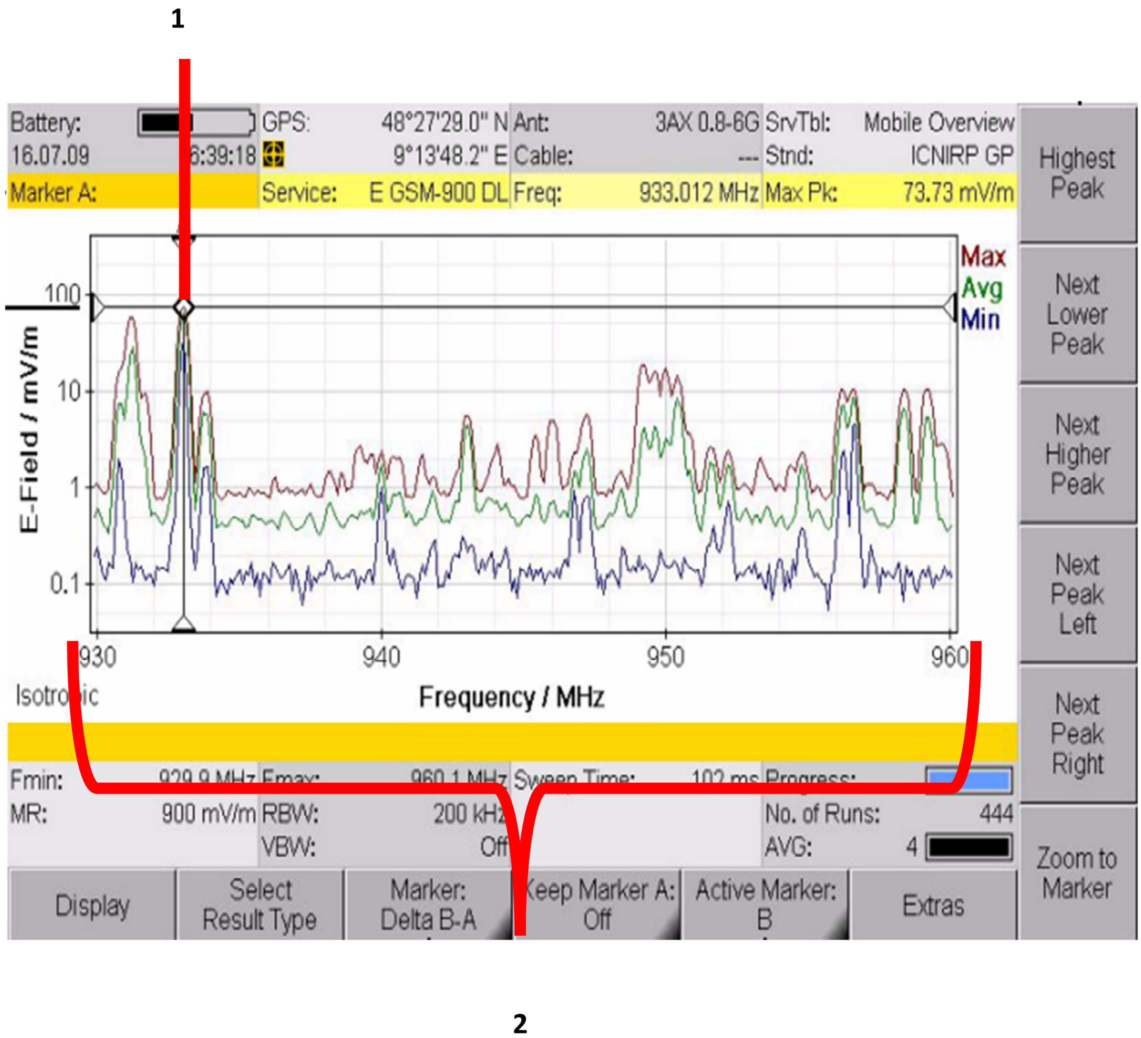


Fig. 3.1. The highest point of interference between the frequency and the electromagnetic field. 2: The frequency values are in MHz.

second field test, 280 readings Table S1 were taken using SRM-3006 equipment to estimate the interference values between frequency and electromagnetic field. Likewise, the largest peaks in Figure (3) for each frequency's interference had been 900, 1800, and 1840 MHz, consecutively.

Eventually, field measurements have been conducted in tandem with mathematical calculations to compute the amount of non-ionizing radiation emitted via cell phone towers and then compare it to (IDNREs), as shown in Table 2.

RESULTS AND DISCUSSIONS

The values between the field and frequency:

The values of radiated field strength and frequency in Figure (4) have shown the fluctuation in the reading between frequencies (F_s) and electromagnetic field (E_f). At 900 MHz, however, the Fs measurements were (932.6, 933.4, and 933.5 MHz).

In contrast, the measurement reading resources assessed (Lokanatha & Prashanth, 2022) of E_f were (103.9, 119.1, and 110.1 dBmV/m) respectively. While the highest readings of interference values have been recorded accordingly, at frequencies 1823.9 and 1845.2 MHz were 102.3, and 124.3 dBmV/m.

Subsequently, all of the values obtained for this combination were quantitatively analyzed

Table 2. Calculation of the values of non-ionizing radiation emitted from cell phone towers to compare it with **(IDNREs)**

Measurement Location: *1	*Responsible:* *2	*Tower site* *3	*Signals* *4				
1	*Asia cell*	*N 314928.9 E 47940.4*	*GSM 900MHz*				
f [MHz] *5	**Limit** *6 **[V/m]**	**E_{max}** *7 **[dBμV/m]**	**E_{max}** *8 **[V/m]**	**E_{max}** *9 **Limit consumption. [%]**	**S_{max}** *10 **[μW/m²]**	**Limit** *11 **[W/m²]**	**S_{max}** *12 **Limit consumption. [%]**
932.6	**41.7**	**103.9**	**0.2**	**0.4**	**64.8**	**4.6**	**0.0**
943.1	**41.7**	**86.9**	**0.0**	**0.1**	**1.3**	**4.6**	**0.0**
952.1	**41.7**	**114.8**	**0.5**	**1.3**	**795.5**	**4.6**	**0.0**
953.3	**41.7**	**107.6**	**0.2**	**0.6**	**150.9**	**4.6**	**0.0**
					1012.5		

*1 Site number of the tower (1-20 towers which measurements),
*2 Mobile network name.
*3 Global Position System (GPS) of mobile tower.
*4 The frequency (f)
*5 Reading points for frequency (900MHz).
*6 IF f>=920, Limit=41.7[V/m], IF f>= 1805,limit=58.4[V/m] and IF f>=2000, Limit= 58.4[V/m].
*7 Electromagnetic –Maximum- field (E_{max})
*8 E_{max}= 0.001*POWER(10;0.05*E_{max} [dBμV/m])/1000:
*9 = 100*E_{max}[v/ m]/limit [v/ m]
10 = 10^6 $(E_{max})^2$/377, then S_{max} represented the summation of values in this Colom, which lead to the result of the amount of non-ionizing radiation emitted divided by 10^{-6} to calculate the final value of non-ionizing radiation emitted from cell phone tower to compare it with **(IDNREs)**
*11 = IF f>=920;Limit=4.61[W/m^2], IF f >=1805; Limit=9.05[W/m^2] and IF f >=2000, Limit=9.1[W/m^2]
*12 =100*S_{max} /Limit[W/m2]*10^{-6}

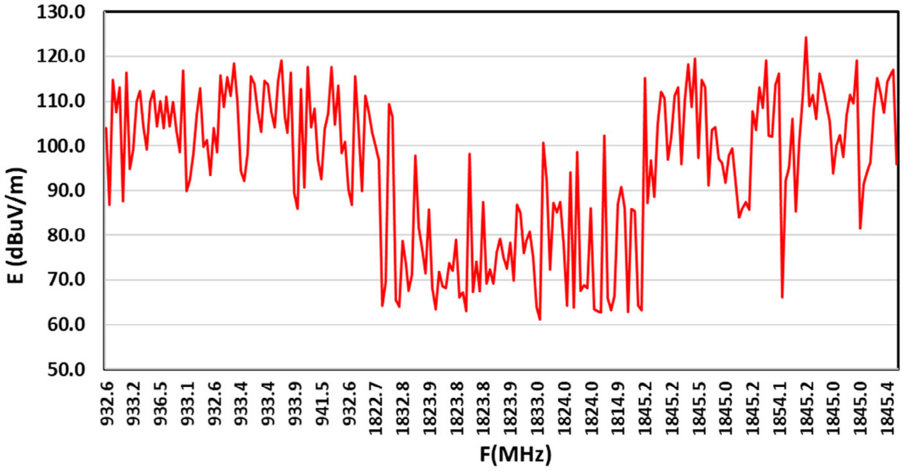


Fig. 4. The values of radiated field strength and frequency

utilizing a worst-case scenario derived from examining the highest peaks that were investigated through statistical analyses(Kapetanakis et al., 2022). This eventually revealed that they were all below what had been prescribed in IDNREs.

Further, the power density emitted per frequency has been estimated to evaluate the degree of the impact of non-ionizing radiation by comparing it to the legal determinant allowed emission (IDNREs).

At frequency 900 MHz when the domain of readings among (930.0-935.0 MHz, 940.0-945.0 MHz, and 950.0-960.0 MHz) the highest readings of confiscated non-ionizing radiation were recorded (1276, $2x10^{-6}$, $1786.3x10^{-6}$ and, $3347.4x10^{-6}$ µW/cm2) respectively Figure (S2a).

Whenever frequencies measurements were being utilized, (1800 MHz) domains (1820.0-1825.0 MHz, 1830.0-1835 MHz, and 1835-1845 MHz) figure (S2b), obtained the highest readings respectively ($227.86x10^{-6}$, $31.35x10^{-6}$ and, $1.44x10^{-6}$ µW/cm^2).

Subsequently (7205.41x10-6, 2369.51x10-6, 2156.05x10-6, and 1095.62x10-6 W/cm2), the highest frequency (1840MHz) values were identified throughout domains (1844.0-1854.0 MHz), as illustrated in Figure S2c: (7205.41x10-6, 2369.51x10-6, 2156.05x10-6, and 1095.62x10-6 W/cm2).

Power absorbed by a human organism estimated Communications

Telecom companies place base transceiver stations at strategic locations. Our foremost concern is the inhabitants who live in the selected cell towers exposure and their health repercussions. (Premlal & Eldhose, 2017; Vijay & Choudhary, 2017).

Therefore, the microwave power absorbed by the human body when exposed to cell tower radiation is determined by modeling the body as a cylinder (this is done to determine the body's curved surface area):

The curved surface area of a cylindrical (CSA) equals 2r x-height, assuming the human waist is 2r. If the height is 1.524m and the waist is 0.889m, the curved surface area of a human torso (CSA) equals 0.889 x 1.524 = 1.513 m^2(Adekunle et al., 2015)

Taking into account, the data mentioned and entering them within the scope of our work through the equation represented power density (Pd) by (Pd= CSA x Smax) for each reading of the frequencies (900, 1800, and 1840 MHz) respectively.

Therefore, the values of power density absorbed by the human body at 900 MHz were recorded its highest value record its highest value (3324 Watts) at a range of readings (930-935 MHz).

While the highest value (535 Watts) was obtained at a reading frequency (940-945 MHz). Whereas, the value of the Pd adsorbed by the human body was recorded highest recorded (2795 Watts) at readings (950-960 MHz) of the frequency (900 MHz) (Figure 5a). Furthermore, at the frequencies (1800 and 1845 MHz) specifically at a range (of 1820-1825 MHz) and (1845-1850 MHz) respectively, recorded the highest value of Pd up to date (344 and 10901 Watts) Figure (5b) and Figure (5c).

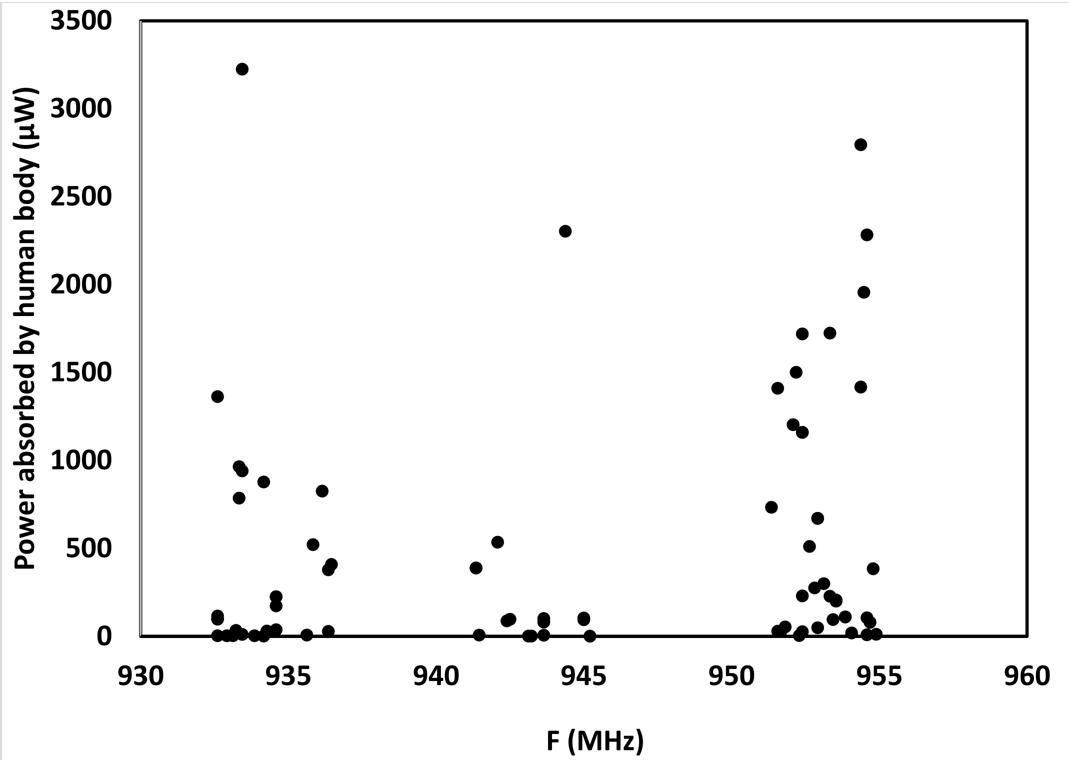


Fig. 5a. The values of power density absorbed by the human body at 900 MHz

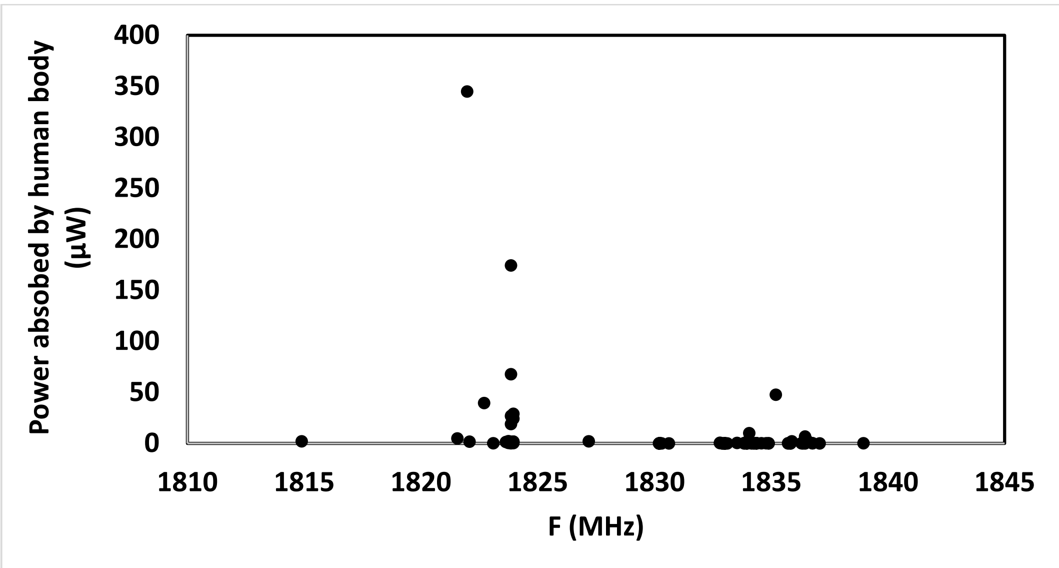


Fig. 5b. The values of power density absorbed by the human body at 1800 MHz

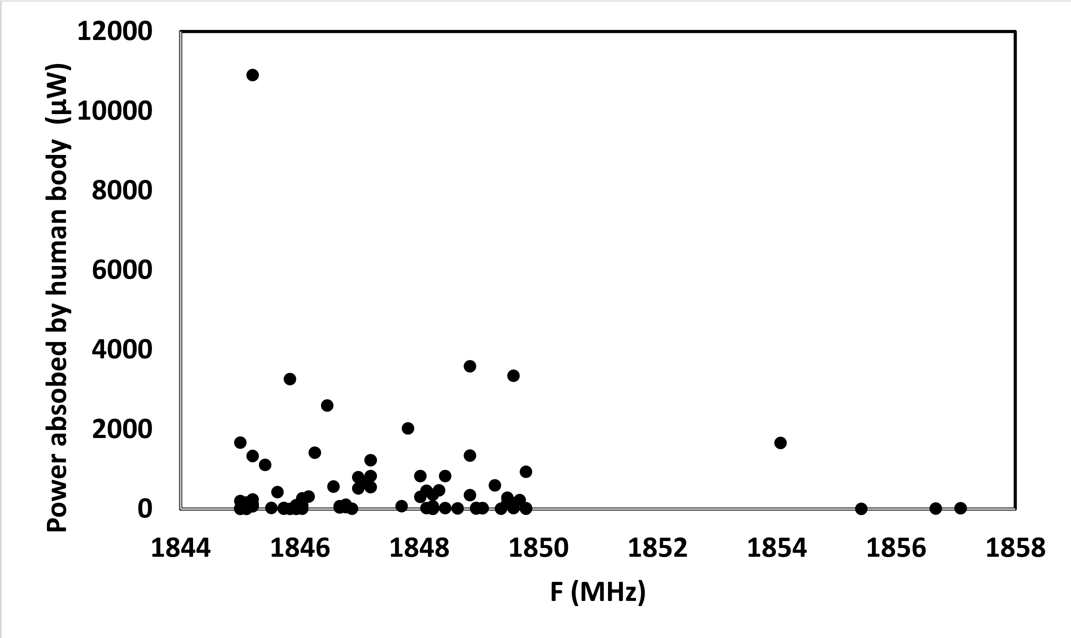


Fig. 5c. The values of power density absorbed by the human body at 1845 MHz

CONCLUSION

In closing, our findings imply merely all of the measurements examined throughout the sample of 20 towers propagated in various regions of the city center, the values of non-ionizing radiation emanating therefrom them, all of which (900, 1800, and 1845 MH_Z) were each beneath (IDNREs). Where, its highest value was reported confiscated non-ionizing radiation values (1276, 2x10-6, 1786.3x10-6, and 3347.4x10-6 W/cm2) occurred at frequency 900 MHz as the domain of measurements among (930.0-935.0 MHz, 940.0-945.0 MHz, and 950.0-960.0 MHz) was recorded. Whilst achieved the maximum values (227.86x10-6, 31.35x10-6, and 1.44x10-6 W/cm2) occurred at frequency 1800 MHz. Following that, the greatest frequency (1840MHz) values were determined throughout domains (1844.0-1854.0 MHz), as demonstrated in (7205.41x10-6, 2369.51x10-6, 2156.05x10-6, and 1095.62x10-6 W/cm2).

Our future goals include large-scale electromagnetic field measurements encompassing the governorate center completely, and then expanding them to include governorate districts and districts. Investigating the electromagnetic fields produced by solar explosions and the amount to which they interact as they enter Earth's space at the governorate level, as well as their interaction with the electromagnetic fields produced by the Earth via these towers. Extending the research requires coordinated efforts across disciplines to determine the extent to which non-ionizing radiation can damage humans, animals, and plants.

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CONFLICT OF INTEREST

The authors declare that there is not any conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/ or falsification, double publication and/or submission, and redundancy has been completely observed by the authors.

LIFE SCIENCE REPORTING

No life science threat was practiced in this research.

REFERENCES

Abdelzaher, M. A., & Shehata, N. (2022). Hydration and synergistic features of nanosilica-blended high alkaline white cement pastes composites. *Applied Nanoscience, 12*(5), 1731-1746.

Adekunle, A., Ibe, K., Kpanaki, M., Umanah, I., Nwafor, C., & Essang, N. (2015). Evaluating the effects of radiation from cell towers and high tension power lines on inhabitants of buildings in Ota, Ogun state. *Communications in Applied Sciences, 3*(1).

Akakin, D., Tok, O. E., Anil, D., Akakin, A., Sirvanci, S., Sener, G., & Ercan, F. (2021). Electromagnetic waves from mobile phones may affect rat brain during development. *Turk. Neurosurg, 31*, 412-421.

Al-Tamer, M. Y., & Al-Ahmady, K. K. MEASUREMENT OF LEVELS OF ELECTROMAGNETIC ENERGY DENSITY EMITTED BY MOBILE PHONE TOWERS IN THE CITY OF MOSUL, IRAQ.

Bauer, J., O'Mahony, C., Chovan, D., Mulcahy, J., Silien, C., & Tofail, S. A. (2019). Thermal effects of mobile phones on human auricle region. *Journal of thermal biology, 79*, 56-68.

Bhargav, H., Varambally, S., & Gangadhar, B. (2015). Effect of Mobile Phone-Induced Electromagnetic Field on Brain Hemodynamics and Human Stem Cell Functioning. *Journal of Stem Cells ISSN, 1556*, 8539.

Chowdhury, A., Singh, Y., Das, U., Waghmare, D., Dasgupta, R., & Majumder, S. K. (2021). Effects of mobile phone emissions on human red blood cells. *Journal of Biophotonics, 14*(8), e202100047.

Döken, B., & Kartal, M. (2016). Triple band frequency selective surface design for global system for mobile communication systems. *IET Microwaves, Antennas & Propagation, 10*(11), 1154-1158.

Elkhouly, H. I., Abdelzaher, M., & El-Kattan, I. M. (2021). Experimental and modeling investigation of physicomechanical properties and firing resistivity of cement pastes incorporation of micro-date seed waste. *Iranian Journal of Science and Technology, Transactions of Civil Engineering*, 1-13.

Gherardini, L., Ciuti, G., Tognarelli, S., & Cinti, C. (2014). Searching for the perfect wave: the effect of radiofrequency electromagnetic fields on cells. *International journal of molecular sciences, 15*(4), 5366-5387.

Gupta, S., Sharma, R. S., & Singh, R. (2022). Non-ionizing radiation as possible carcinogen. *International Journal of Environmental Health Research, 32*(4), 916-940.

Hardell, L. (2018). Effects of mobile phones on children's and adolescents' health: A commentary. *Child development, 89*(1), 137-140.

Hardell, L., Carlberg, M., & Mild, K. H. (2013). Use of mobile phones and cordless phones is associated with increased risk for glioma and acoustic neuroma. *Pathophysiology, 20*(2), 85-110.

Hussain, D., Ali, A. H., Mazhir, S. N., & Juma, A. (2014). Study the Effect of Mobile (Cell Phone) on the Heart Electricity. *Int. J. of Appl. Inf. Sys.(IJAIS), FCS, New York, USA*.

Källander, K., Tibenderana, J. K., Akpogheneta, O. J., Strachan, D. L., Hill, Z., ten Asbroek, A. H., . . . Meek, S. R. (2013). Mobile health (mHealth) approaches and lessons for increased performance and retention of community health workers in low-and middle-income countries: a review. *Journal of medical Internet research, 15*(1), e2130.

Kapetanakis, T. N., Ioannidou, M. P., Baklezos, A. T., Nikolopoulos, C. D., Sergaki, E. S., Konstantaras, A. J., & Vardiambasis, I. O. (2022). Assessment of Radiofrequency Exposure in the Vicinity of School Environments in Crete Island, South Greece. *Applied Sciences, 12*(9), 4701.

Kaur, S., Kaur, J., & Sandhu, M. (2016). Effects of mobile radiations and its prevention. *International Journal of Computer Science and Mobile Computing, 5*(2), 298-304.

Keykhosravi, A., Neamatshahi, M., Mahmoodi, R., & Navipour, E. (2018). Radiation effects of mobile phones and tablets on the skin: a systematic review. *Advances in medicine, 2018*.

Leng, L., & Zhang, Y. (2016). Etiology of pituitary tumors: A case control study. *Turk Neurosurg, 26*(2), 195-199.

Li, H., Yue, J., Wang, Y., Zou, F., Zhang, M., & Wu, X. (2021). Negative effects of mobile phone addiction tendency on spontaneous brain microstates: evidence from resting-state EEG. *Frontiers in Human Neuroscience, 15*, 636504.

Lokanatha, S. B., & Prashanth, S. B. B. (2022). Design and performance analysis of human body communication digital transceiver for wireless body area network applications. *International Journal of Electrical and Computer Engineering, 12*(3), 2206.

Owaid, K. A., Hamdoon, A. A., Matti, R. R., Saleh, M. Y., & Abdelzaher, M. (2022). Waste Polymer and Lubricating Oil Used as Asphalt Rheological Modifiers. *Materials, 15*(11), 3744.

Premlal, P., & Eldhose, N. (2017). Mobile tower radiation-an assessment of radiation level and its health implications in the residential areas of western ghats in idukki, Kerala. *Int. J. Appl. Eng. Res, 12*(20), 9548-9554.

Rasheed, A. F. (2020). Assess the Adverse Consequences of Electromagnetic Radiation Emissions for Communications Technique. *Solid State Technology, 63*(1), 1018-1024.

ŞAHİN, M., Nilüfer, A., & Karan, Y. (2013). Selective radiation measurement for safety evaluation on base stations. *Gazi University Journal of Science, 26*(1), 73-83.

Salih, A., Saeed, A. T., & Saber, Z. R. (2019). A Study on the Effects of Cellular Mobile Networks on People in Tikrit City Based on Power Density Measurements and Calculations. *Engineering, Technology & Applied Science Research, 9*(3), 4265-4270.

Upadhyaya, C., Upadhyaya, T., & Patel, I. (2022a). Attributes of non-ionizing radiation of 1800 MHz frequency on plant health and antioxidant content of Tomato (Solanum lycopersicum) plants. *Journal of Radiation Research and Applied Sciences, 15*(1), 54-68.

Upadhyaya, C., Upadhyaya, T., & Patel, I. (2022b). Exposure effects of non-ionizing radiation of radio waves on antimicrobial potential of medicinal plants. *Journal of Radiation Research and Applied Sciences, 15*(1), 1-10.

Vijay, S., & Choudhary, M. P. (2017). Study on health effects of mobile tower radiation on human beings. *Int. Res. J. Eng. Technol, 4*(11), 1548-1552.

Yang, M., Guo, W., Yang, C., Tang, J., Huang, Q., Feng, S., . . . Jiang, G. (2017). Mobile phone use and glioma risk: A systematic review and meta-analysis. *PloS one, 12*(5), e0175136.