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Harmfulness of 5G Transmission from Mobile Phone Towers

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Abstract- In today's time the world is going digital. In digital world most people use of mobile phone to convey the information, for which towers receive a signal and transmit it back to mobile set. For this, transmission towers emit the radiation. The increased electromagnetic radiation emitted by towers may possibly affect the human health. Radiation penetrates the human body and is absorbed by the human tissues. To know the possibility of harmfulness we calculate the penetrated field in human body for two different frequencies and for different values of power with the help of SAR formula and the results are compared with the permitted whole-body SAR value recommended by different agencies. Calculating the value of specific absorption rate (SAR) for 5G frequencies from transmission towers it is shown that harmfulness increases in higher frequencies of transmission. Harmfulness reaches to longer distances in higher generation of transmission.

Keywords: electromagnetic field, Penetration of field, radiated power, skin-depth, etc.

I. INTRODUCTION

The rapid advancement of technology in recent years has brought about numerous innovations that have transformed the way we live, communicate, and interact with the world around us. Base station towers are required for data transfer. They emit high frequency field in the range of few hundred MHz to few GHz. The electromagnetic field is higher near the transmission tower [1]. They calculate the value of specific absorption rate (SAR) for different distances from transmission tower at different frequencies and results show that the SAR value is increased with decreasing distance and increasing frequency. When radiation fall upon human body, the body temperature increases because some radiation is absorbed by human tissue. The penetrated electric field and SAR values for different tissues at 41 and 202 MHz frequency are calculated [2-4].

The human health problems due to the GSM service providers in the state Jigawa (Nigeria), shows that services provided by Airtel, Glo, MTN and Etisalat telecommunication companies are under the safe limit given by ICNIRP standard [5]. The SAR value and effect of the electric field for human head at 900 MHz and 1800 MHz for SAM (a software model) head tissues are calculated and in this working the monopole antenna was used [6]. The effect of temperature at various frequencies active in mobile phone, shows that the antenna heat raises the body temperature. Increase in temperature causes much serious effect on human body tissues [7]. The value of power density due to all mobile phone tower across the whole city (Gusau) in Zamfara state was calculated [8]. The increasing use of cell phones for long period of time, harmful effects from EM waves are resulted on human health [9]. Power density, electric field, and SAR for different coordinate at 900 MHz and 1800 MHz frequency are calculated [10]. The value of electric field, magnetic field, and power density around the four directions of cell phone tower are calculate at two distances 50 m and 100 m [11]. These calculations show that SAR value is higher at for larger frequencies. 5G network are being deployed all over the world which uses much higher frequencies for transmission thus increasing the chance of harmful effect on human health. Thus, the area of concern is the potential harm caused by 5G transmission from mobile phone towers. Therefore, in this paper we calculate the SAR for different value of power P at frequencies of 3300 MHz and 4900 MHz (frequencies of 5G spectrum).

II. LITERATURE REVIEW:

Non-ionizing radiation can always pierce the skin while it does not change the human body's molecular structure [12]. Lage amount of non-ionizing radiation carry the power to heat tissues in the body. The prospect that the electromagnetic energy is going to enter more deeply grows with a higher concentration of

electromagnetic energy. The skin heat up is an inevitable outcome of this exposure and depending on how severe it is, it may additionally impact on various other organs [13-15]. Radio waves are utilized via a cell phone towers for both the transferring and receiving information. Chronic exposure cosmic ray has been suspected of several type of medical issues especially mental retardation, change in metabolism, consequences for overall heath and disturbances in neural activity. There are several and unexpected way to experience of radiation contamination in the atmosphere, consequence of the developing technology required to support 5G connections and increasing proportion of smartphone owners. These weaknesses are aggravated by an increasing variety of communications satellites.

A lot of creatures, especially human beings show health ramifications associate with these exposures, even when they are barely detectable rates corresponding to contemporary environment [16-18]. It is help to understand the peculiarities of the EMF propagation of ground state along with maximum voltage energy transfer poles and to assess the relevant human susceptibility to such areas in order to ensure the secure use and examination of communication pole [19].

A number of investigations have projected the optimum EM radiation generated by LTE towers via determining radiant area magnitude produced by coordination indications and a result of these studies the radiation properties of base station as well. Since cellular ray helps it simpler to stay in touch, share information and execute surveys, here is a considerable data to show classic and modern Bluetooth communication eras my possess negative consequences on health of individuals. These illustrates the importance to meticulously evaluate and limit radiofrequency radiations to safeguard the welfare of people [20]. The influence of EMF exposure, the variation of temperature, SAR and electric field within the various body part has been researched. This investigation revealed that when bombarded by electromagnetic energy, the dielectric feature of the cells exerts an enormous effect on how energy is circulated into the body tissues. These are provided vital data towards restricting the energetic released by transmission device, establishing calculate secure boundaries separating human beings and those type of device to make sure exposure stays outside acceptable limits [21-22].

Extending the number of base stations in a certain region, notable at the 28 GHz frequency, enable an innovative means to regulate the contact with electromagnetic fields. This evolution provides it achievable to reduce radiation exposure via a specific method. These results encompass PD, conductivity of electrical current, permittivity value, frequency range, SAR, temperature and amount of EMF. It is conceivable to limit and decrease the adverse impact of radiation on human wellness despite sustaining optimum network performance by controlling above factor [23-25]. Although numerous antennas pole has been constructed to endure high power and frequency emission from ground stations the EM field encircle them is complicated compared to one another routine energy transfer towers. The fact that people face exposed to more powerful amount of EMF, assessing these towers becoming harder to do. Significant and shockingly solid proof implies an increased danger several types of cancer in adults, whereas a lot of the conversation concerning whether EMF push the possibility of cancer has focused on leukaemia in kid [26-27].

III. MATERIAL AND METHODS

Electric field around mobile phones transmission tower

The electromagnetic fields in the microwave frequency domain which are usually released by mobile phone towers have a maximum intensity close to the towers and decrease with distance since the intensity of these fields is inversely proportional to the square root of the distance. The electric field E, value at a distance r from the power P vertical transmitting antenna but antenna length l<< r so that propagated wave front is spherical, is given by following equation [28-29]

$$E = \sqrt{\frac{P}{2\pi r^2 \varepsilon_0 c}} \quad (1)$$

Where, ε_0 = permittivity of free space, c = speed of light

This indicates that the electric field changes inversely proportionate to the square root of the transmission tower's distance.

Penetration of electric field into human body

The permeability, permittivity, and radiation frequency all affect deeply a field penetrate human tissue when it is exposed to radiation. Consequently, the field caused by the incident electric field, E, on the surface at a depth, d, is given as [30]

$$E_i = E\, e^{(-\frac{d}{\delta})} \quad (2)$$

Where, δ is the skin depth, it is given as

$$\delta = {}^{1}/_{a\omega}$$

$$a = [\mu\varepsilon\left\{(1+s^2)^{1/2} - 1\right\}/2\,]^{1/2}$$

$$s = {}^{\sigma}/_{\omega\varepsilon}$$

Specific absorption rate

The Specific absorption rate (SAR) is given by

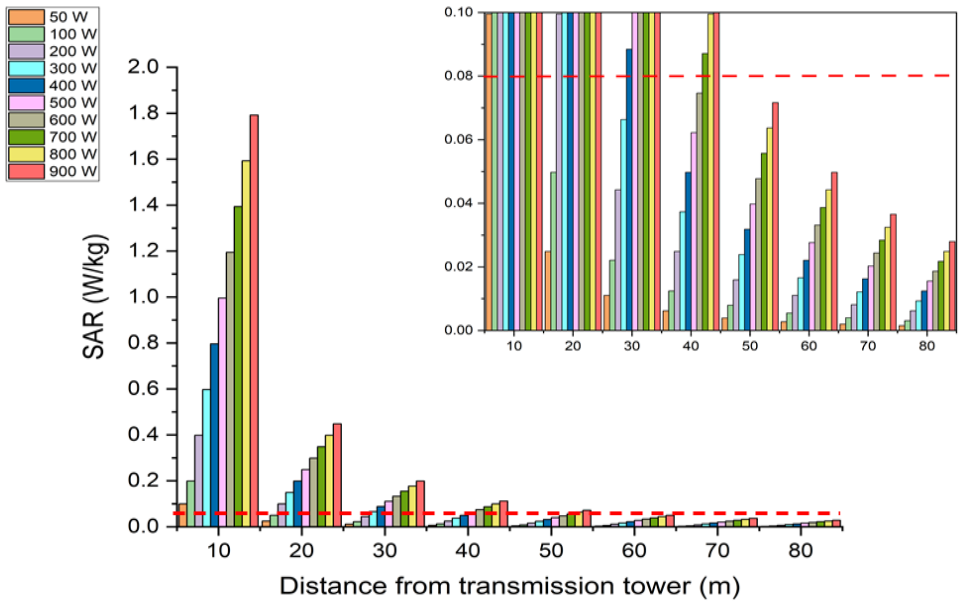
$$SAR = \frac{\sigma E_i^2}{\rho} \quad (3)$$

Where, ρ is the mass density of the tissue material.

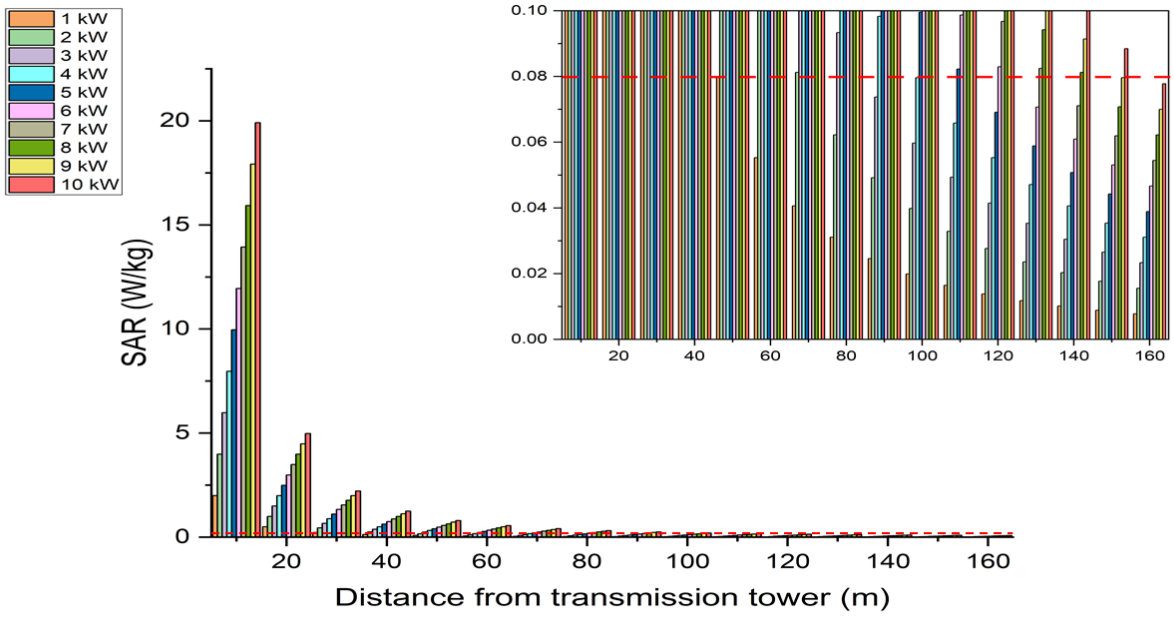
IV. RESULTS AND DISCUSSION

The emergence of 5G technology has ushered in a new area of connectivity with possibilities for larger bandwidth and internet speeds. However, the potential harmfulness of 5G transmission from mobile phone towers cannot be dismissed lightly. The resulting SAR, i.e., absorption of electromagnetic field in the human body at different distances from mobile transmission tower at 3300 MHz and 4900 MHz frequencies at different transmission powers are calculated and given in Figure 1 and Figure 2. To enhance the understanding of the harmful range of Specific Absorption Rate (SAR) at 0.08 W/kg, magnified portions of each graph have been depicted. These detailed views highlight the critical areas where SAR levels can become potentially harmful, providing a clearer visual representation of exposure thresholds. This allows for better comprehension of how even small increases in SAR can affect biological tissues. The results shows that SAR values increase with increase of power and decrease of distance from transmission towers. The resulting values of SAR are compared with safe exposure limit for whole body SAR 0.08 W/kg as recommended by world health organization (WHO) [31], Federal Communication Commission (FCC) [32], International Commission on Non-ionizing Radiation Protection (ICNIRP) [33], the Institute of Electrical and Electronics Engineers (IEEE) [34], National Council on Radiation Protection and measurement (NCRP) [19], Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) [35] etc. The values more than permissible limit are shown in Figure 1 and Figure 2 is representing the comparison of two frequency 3300 MHz and 4900 MHz at power show the safe distance from the transmission towers decreases on increasing the frequency value, for same frequencies SAR variation with different power shows safe distance limit is decreasing by increasing in frequency as well as power, these results shown in figure 3, i.e., the people are affected up to lager distances from transmission towers.

This shows that shifting to 5G is going to be more harmful for human as also to other biosystems including birds and animals. Scientists all over the world are opposing the switch over to 5G transmission, but governments are in race to introduce it faster in their countries. Many countries are even considering 6G, which is going to produce havoc throughout the world.



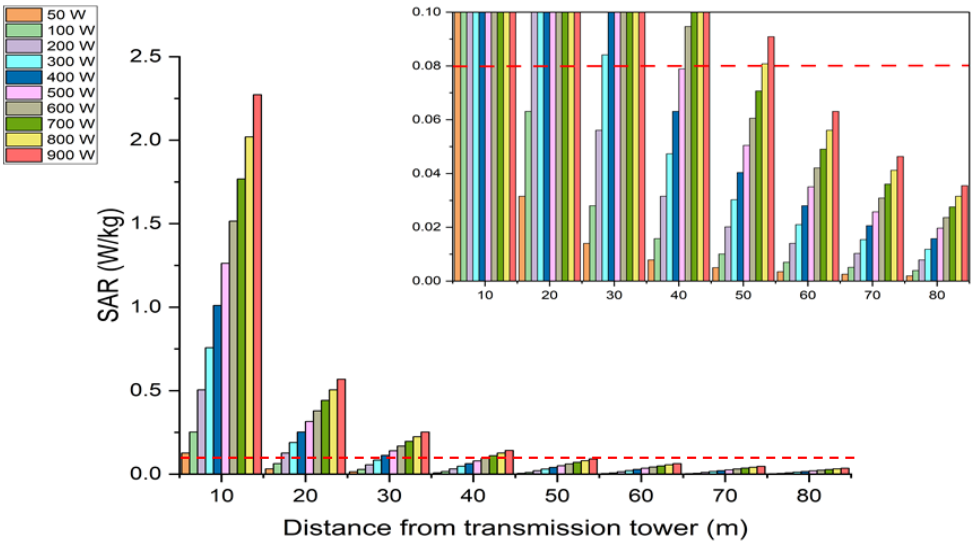
1(a)



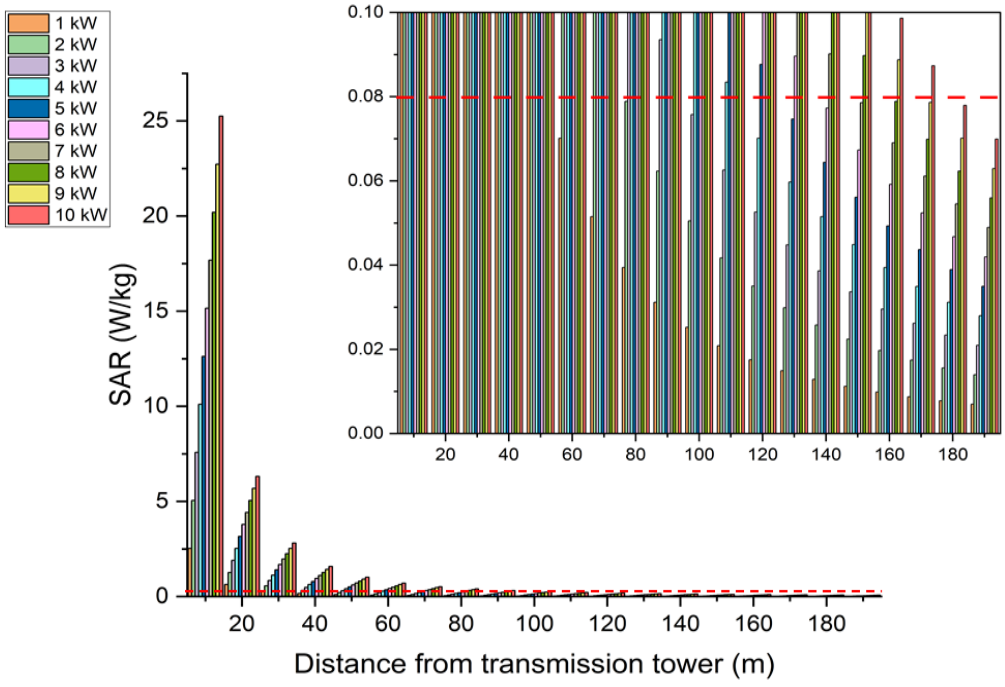
1(b)

Figure 1(a) and 1(b): Variation of SAR in human body at 3300 MHz frequency with variation of power (W)

(a) 50 W- 900 W (b) 1 kW- 10 kW

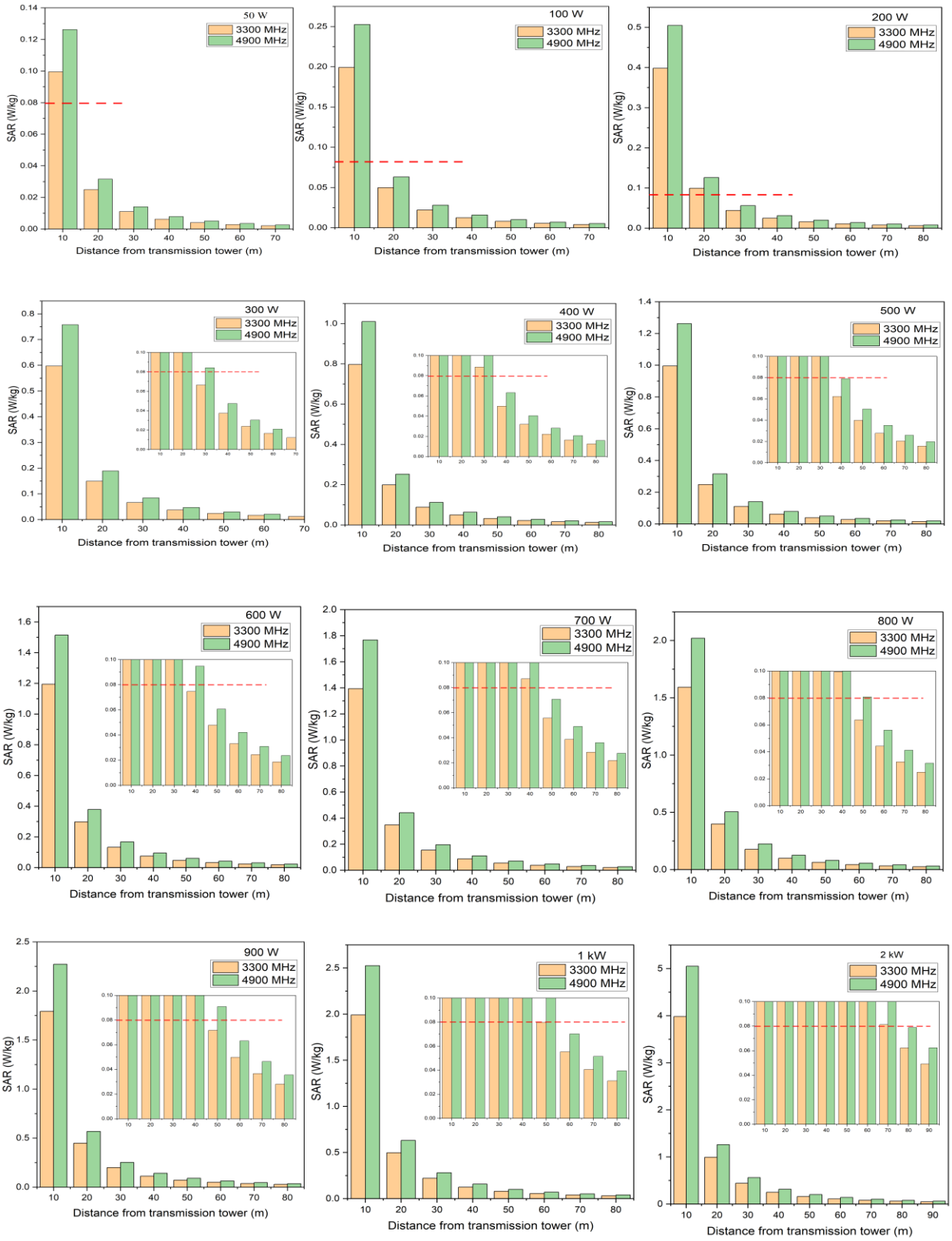

50 W
100 W
200 W
300 W
400 W
500 W
600 W
700 W
800 W
900 W
SAR (W/kg)
Distance from transmission tower (m)

2(a)


1 kW
2 kW
3 kW
4 kW
5 kW
6 kW
7 kW
8 kW
9 kW
10 kW
SAR (W/kg)
Distance from transmission tower (m)

2(b)

Figure 2(a) and 2(b): Variation of SAR in human body at 4900 MHz frequency with variation of power (W)
(a) 50 W- 900 W (b) 1 kW- 10 kW



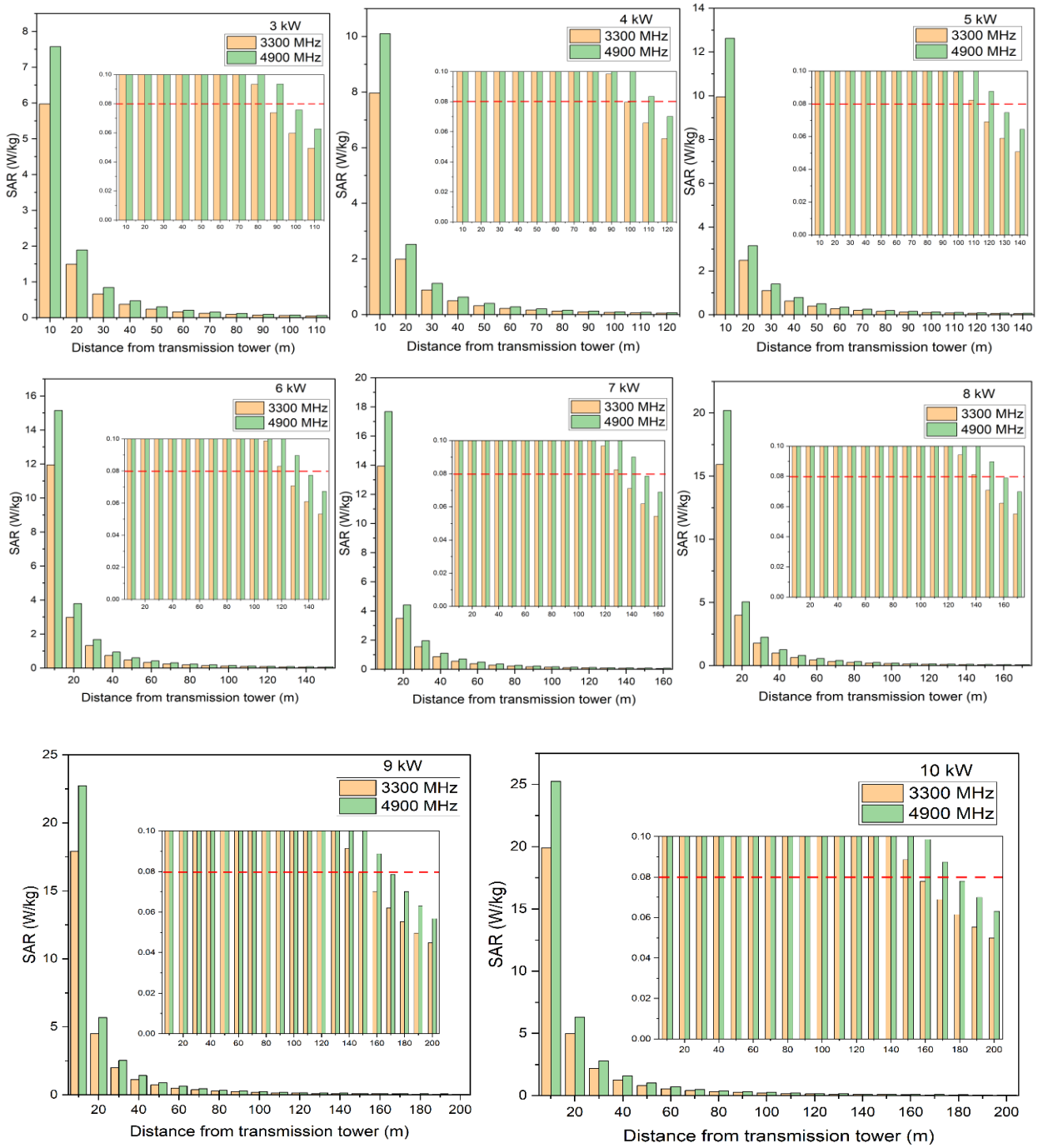


Figure3: Variation of SAR in human body at two different frequencies with power (W)

s.no.	Distance from transmission tower (m)	Variation of SAR in human body at different power P (W)									
		50 W	100 W	200 W	300 W	400 W	500 W	600 W	700 W	800 W	900 W
1	10	**0.09955249 1**	**0.19910498 1**	**0.39820996 3**	**0.59731494 4**	**0.79641992 6**	**0.99552490 7**	**1.19462988 8**	**1.39373487**	**1.59283985 1**	**1.79194483 3**
2	20	0.024888123	0.049776245	**0.09955249 1**	**0.14932873 6**	**0.19910498 1**	**0.24888122 7**	**0.29865747 2**	**0.34843371 7**	**0.39820996 3**	**0.44798620 8**
3	30	0.011061388	0.022122776	0.044245551	0.066368327	**0.08849110 3**	**0.11061387 9**	**0.13273665 4**	**0.15485943**	**0.17698220 6**	**0.19910498 1**
4	40	0.006222031	0.012444061	0.024888123	0.037332184	0.049776245	0.062220307	0.074664368	**0.08710842 9**	**0.09955249 1**	**0.11199655 2**
5	50	0.0039821	0.007964199	0.015928399	0.023892598	0.031856797	0.039820996	0.047785196	0.055749395	0.063713594	0.071677793
6	60	0.002765347	0.005530694	0.011061388	0.016592082	0.022122776	0.02765347	0.033184164	0.038714857	0.044245551	0.049776245
7	70	0.002031683	0.004063367	0.008126734	0.012190101	0.016253468	0.020316835	0.024380202	0.028443569	0.032506936	0.036570303
8	80	0.001555508	0.003111015	0.006222031	0.009333046	0.012444061	0.015555077	0.018666092	0.021777107	0.024888123	0.027999138
9	90	0.001229043	0.002458086	0.004916172	0.007374259	0.009832345	0.012290431	0.014748517	0.017206603	0.01966469	0.022122776
10	100	0.000995525	0.00199105	0.0039821	0.005973149	0.007964199	0.009955249	0.011946299	0.013937349	0.015928399	0.017919448
11	110	0.000822748	0.001645496	0.003290991	0.004936487	0.006581983	0.008227479	0.009872974	0.01151847	0.013163966	0.014809461
12	120	0.000691337	0.001382673	0.002765347	0.00414802	0.005530694	0.006913367	0.008296041	0.009678714	0.011061388	0.012444061
13	130	0.000589068	0.001178136	0.002356272	0.003534408	0.004712544	0.00589068	0.007068816	0.008246952	0.009425088	0.010603224
14	140	0.000507921	0.001015842	0.002031683	0.003047525	0.004063367	0.005079209	0.00609505	0.007110892	0.008126734	0.009142576
15	150	0.000442456	0.000884911	0.001769822	0.002654733	0.003539644	0.004424555	0.005309466	0.006194377	0.007079288	0.007964199

16	160	0.000388877	0.000777754	0.001555508	0.002333262	0.003111015	0.003888769	0.004666523	0.005444277	0.006222031	0.006999785
17	170	0.000344472	0.000688945	0.001377889	0.002066834	0.002755778	0.003444723	0.004133667	0.004822612	0.005511557	0.006200501
18	180	0.000307261	0.000614522	0.001229043	0.001843565	0.002458086	0.003072608	0.003687129	0.004301651	0.004916172	0.005530694
19	190	0.000275769	0.000551537	0.001103075	0.001654612	0.002206149	0.002757687	0.003309224	0.003860761	0.004412299	0.004963836
20	200	0.000248881	0.000497762	0.000995525	0.001493287	0.0019 9105	0.002488812	0.002986575	0.003484337	0.0039821	0.004479862

Table 1(a): Variation of SAR in human body at 3300 MHz frequency with different power (50W – 900W)

s. no.	Distance from transmission tower (m)	Variation of SAR in human body at different power P (W)									
		1 kW	2 kW	3 kW	4 kW	5 kW	6 kW	7 kW	8 kW	9 kW	10 kW
1	10	**1.991049814**	**3.982099628**	**5.973149442**	**3.982099628**	**9.955249078**	**11.94629888**	**13.93734871**	**15.92839851**	**17.91944833**	**19.91049814**
2	20	**0.497762454**	**0.995524907**	**1.493287361**	**0.995524907**	**2.488812268**	**2.986574721**	**3.484337175**	**3.982099628**	**4.479862082**	**4.977624535**
3	30	**0.221227757**	**0.442455514**	**0.663683271**	**0.442455514**	**1.106138786**	**1.327366543**	**1.5485943**	**1.769822057**	**1.991049814**	**2.212277571**
4	40	**0.124440613**	**0.248881227**	**0.37332184**	**0.248881227**	**0.622203067**	**0.74664368**	**0.871084294**	**0.995524907**	**1.11996552**	**1.244406134**
5	50	**0.079641993**	**0.159283985**	**0.238925978**	**0.159283985**	**0.398209963**	**0.477851955**	**0.557493948**	**0.63713594**	**0.716777933**	**0.796419926**
6	60	0.055306939	**0.110613879**	**0.165920818**	**0.110613879**	**0.276534696**	**0.331841636**	**0.387148575**	**0.442455514**	**0.497762454**	**0.553069393**
7	70	0.040633367	**0.081267339**	**0.121901009**	**0.081267339**	**0.203168348**	**0.243802018**	**0.284435688**	**0.325069357**	**0.365703027**	**0.406336697**

8	80	0.031110153	0.062220307	**0.09333046**	0.062220307	**0.15555076 7**	**0.18666092**	**0.21777107 3**	**0.24888122 7**	**0.27999138**	**0.31110153 3**
9	90	0.024580862	0.049161724	0.073742586	0.049161724	**0.12290431**	**0.14748517 1**	**0.17206603 3**	**0.19664689 5**	**0.22122775 7**	**0.24580861 9**
10	100	0.019910498	0.039820996	0.059731494	0.039820996	**0.09955249 1**	**0.11946298 9**	**0.13937348 7**	**0.15928398 5**	**0.17919448 3**	**0.19910498 1**
11	110	0.016454957	0.032909914	0.049364871	0.032909914	**0.08227478 6**	**0.09872974 3**	**0.1151847**	**0.13163965 7**	**0.14809461 4**	**0.16454957 1**
12	120	0.013826735	0.02765347	0.041480204	0.02765347	0.069133674	**0.08296040 9**	**0.09678714 4**	**0.11061387 9**	**0.12444061 3**	**0.13826734 8**
13	130	0.011781 36	0.023562 72	0.035344 08	0.023562 72	0.058906799	0.070688159	**0.08246951 9**	**0.09425087 9**	**0.10603223 9**	**0.11781359 8**
14	140	0.010158417	0.020316835	0.030475252	0.020316835	0.050792087	0.060950505	0.071108922	**0.08126733 9**	**0.09142575 7**	**0.10158417 4**
15	150	0.008849 11	0.017698221	0.026547331	0.017698221	0.044245551	0.053094662	0.061943772	0.070792882	**0.07964199 3**	**0.08849110 3**
16	160	0.007777538	0.015555077	0.023332615	0.015555077	0.038887692	0.04666523	0.054442768	0.062220307	0.069997845	**0.07777538 3**
17	170	0.006889446	0.013778891	0.020668337	0.013778891	0.034447229	0.041336674	0.04822612	0.055115566	0.062005012	0.068894457
18	180	0.006145215	0.012290431	0.018435646	0.012290431	0.030726077	0.036871293	0.043016508	0.049161724	0.055306939	0.061452155
19	190	0.005515373	0.011030747	0.01654612	0.011030747	0.027576867	0.033092241	0.038607614	0.044122988	0.049638361	0.055153734
20	200	0.004977625	0.009955249	0.014932874	0.009955249	0.024888123	0.029865747	0.034843372	0.039820996	0.044798621	0.049776245

Table 1(b): Variation of SAR in human body at 3300 MHz frequency with different power (1 kW – 10 kW)

s. no.	Distance from transmission tower (m)	Variation of SAR in human body at different power P (W)									
		50 W	100 W	200 W	300 W	400 W	500 W	600 W	700 W	800 W	900 W
1	10	**0.12625155 8**	**0.25250311 6**	**0.50500623 3**	**0.75750934 9**	**1.01001246 5**	**1.26251558 2**	**1.51501869 8**	**1.76752181 5**	**2.02002493 1**	**2.27252804 7**
2	20	0.03156289	0.06312 5779	**0.12625155 8**	**0.18937733 7**	**0.25250311 6**	**0.31562889 5**	**0.37875467 5**	**0.44188045 4**	**0.50500623 3**	**0.56813201 2**
3	30	0.01402 7951	0.02805 5902	0.05611804	**0.08416770 5**	**0.11222360 7**	**0.14027950 9**	**0.16833541 1**	**0.19639131 3**	**0.22444721 5**	**0.25250311 6**
4	40	0.00789 0722	0.01578 1445	0.03156289	0.04734 4334	0.06312 5779	0.07890 7224	**0.09468866 9**	**0.11047011 3**	**0.12625155 8**	**0.14203300 3**
5	50	0.00505 0062	0.01010 0125	0.02020 0249	0.03030 0374	0.04040 0499	0.05050 0623	0.06060 0748	0.07070 0873	**0.08080099 7**	**0.09090112 2**
6	60	0.00350 6988	0.00701 3975	0.01402 7951	0.02104 1926	0.02805 5902	0.03506 9877	0.04208 3853	0.04909 7828	0.05611804	0.06312 5779
7	70	0.00257 6562	0.00515 3125	0.01030625	0.01545 9374	0.02061 2499	0.02576 5624	0.03091 8749	0.03607 1874	0.04122 4999	0.04637 8123
8	80	0.00197 2681	0.00394 5361	0.00789 0722	0.01183 6084	0.01578 1445	0.01972 6806	0.02367 2167	0.02761 7528	0.03156289	0.03550 8251
9	90	0.00155 8661	0.00311 7322	0.00623 4645	0.00935 1967	0.01246929	0.01558 6612	0.01870 3935	0.02182 1257	0.02493 8579	0.02805 5902
10	100	0.00126 2516	0.00252 5031	0.00505 0062	0.00757 5093	0.01010 0125	0.01262 5156	0.01515 0187	0.01767 5218	0.02020 0249	0.02272528
11	110	0.00104 3401	0.00208 6803	0.00417 3605	0.00626 0408	0.00834721	0.01043 4013	0.01252 0816	0.01460 7618	0.01669 4421	0.01878 1224
12	120	0.00087 6747	0.00175 3494	0.00350 6988	0.00526 0482	0.00701 3975	0.00876 7469	0.01052 0963	0.01227 4457	0.01402 7951	0.01578 1445
13	130	0.00074 7051	0.00149 4101	0.00298 8203	0.00448 2304	0.00597 6405	0.00747 0506	0.00896 4608	0.01045 8709	0.01195281	0.01346 8912
14	140	0.00064 4141	0.00128 8281	0.00257 6562	0.00386 4844	0.00515 3125	0.00644 1406	0.00772 9687	0.00901 7968	0.01030625	0.01159 4531
15	150	0.00056 1118	0.00112 2236	0.00224 4472	0.00336 6708	0.00448 8944	0.00561118	0.00673 3416	0.00785 5653	0.00897 7889	0.01010 0125

16	160	0.00049317	0.00098634	0.00197261	0.00295902	0.00394536	0.00493170	0.00591804	0.00690438	0.00789072	0.00887706
17	170	0.00043685	0.00087371	0.00174742	0.00262114	0.00349485	0.00436856	0.00524227	0.00611599	0.00698970	0.00786341
18	180	0.00038965	0.00077933	0.00155866	0.00233799	0.00311732	0.00389665	0.00467598	0.00545531	0.00623464	0.00701397
19	190	0.00034972	0.00069945	0.00139890	0.00209836	0.00279781	0.00349727	0.00419673	0.00489618	0.00559563	0.00629509
20	200	0.00031562	0.00063125	0.00126251	0.00189377	0.00252503	0.00315628	0.00378754	0.00441880	0.00505006	0.00568132

Table 2(a): Variation of SAR in human body at 4900 MHz frequency with different power (50W – 900W)

s. no.	Distance from transmission tower (m)	Variation of SAR in human body at different power P (W)									
		1 kW	2 kW	3 kW	4 kW	5 kW	6 kW	7 kW	8 kW	9 kW	10 kW
1	10	**2.525031164**	**5.050062327**	**7.575093491**	**10.10012465**	**12.62515582**	**15.15018698**	**17.67521815**	**20.20024931**	**22.72528047**	**25.25031164**
2	20	**0.631257791**	**1.262515582**	**1.893773373**	**2.525031164**	**3.156288955**	**3.787546746**	**4.418804536**	**5.050062327**	**5.681320118**	**6.312577909**
3	30	**0.280559018**	**0.561118036**	**0.841677055**	**1.122236073**	**1.402795091**	**1.683354109**	**1.963913127**	**2.244472145**	**2.525031164**	**2.805590182**
4	40	**0.157814448**	**0.315628895**	**0.473443343**	**0.631257791**	**0.789072239**	**0.946886686**	**1.104701134**	**1.262515582**	**1.42033003**	**1.578144477**
5	50	**0.101001247**	**0.202002493**	**0.303003741**	**0.404004986**	**0.505006233**	**0.606007479**	**0.707008726**	**0.808009972**	**0.909011219**	**1.010012465**
6	60	0.070139755	**0.140279509**	**0.210419264**	**0.280559018**	**0.350698773**	**0.420838527**	**0.490978282**	**0.561118036**	**0.631257791**	**0.701397545**
7	70	0.051531248	**0.103062496**	**0.154593745**	**0.206124993**	**0.257656241**	**0.309187489**	**0.360718738**	**0.412249986**	**0.463781234**	**0.515312482**
8	80	0.039453612	**0.078907224**	**0.118360836**	**0.157814448**	**0.19726806**	**0.236721672**	**0.276175284**	**0.315628895**	**0.355082507**	**0.394536119**
9	90	0.031173224	0.062346448	**0.093519673**	**0.124692897**	**0.155866121**	**0.187039345**	**0.21821257**	**0.249385794**	**0.280559018**	**0.311732242**
10	100	0.025250312	0.050500623	**0.075750935**	**0.101001247**	**0.126251558**	**0.15150187**	**0.176752181**	**0.202002493**	**0.227252805**	**0.252503116**
11	110	0.020868026	0.041736052	0.062604078	**0.083472105**	**0.104340131**	**0.125208157**	**0.146076183**	**0.166944209**	**0.187812235**	**0.208680261**
12	120	0.017534939	0.035069877	0.052604816	0.070139755	**0.087674693**	**0.105209632**	**0.12274457**	**0.140279509**	**0.157814448**	**0.175349386**

13	130	0.014941013	0.029882026	0.044823038	0.059764051	0.074705064	**0.089646077**	**0.10458709**	**0.119528102**	**0.134469115**	**0.149410128**
14	140	0.012882812	0.025765624	0.038648436	0.051531248	0.06441406	**0.077296872**	**0.090179684**	**0.103062496**	**0.115945309**	**0.128828121**
15	150	0.011222361	0.022444721	0.033667082	0.044889443	0.056111804	0.067334164	**0.078556525**	**0.089778886**	**0.101001247**	**0.112223607**
16	160	0.009863403	0.019726806	0.029590209	0.039453612	0.049317015	0.059180418	0.069043821	**0.078907224**	**0.088770627**	**0.09863403**
17	170	0.008737132	0.017474264	0.026211396	0.034948528	0.04368566	0.052422792	0.061159924	0.069897056	**0.078634188**	**0.087371321**
18	180	0.007793306	0.015586612	0.023379918	0.031173224	0.03896653	0.046759836	0.054553142	0.062346448	0.070139755	**0.077933061**
19	190	0.006994546	0.013989092	0.020983638	0.027978185	0.034972731	0.041967277	0.048961823	0.055956369	0.062950915	0.069945462
20	200	0.006312578	0.012625156	0.018937734	0.025250312	0.03156289	0.037875467	0.044188045	0.050500623	0.056813201	0.063125779

Table 2(a): Variation of SAR in human body at 4900 MHz frequency with different power (1 kW – 10 kW)

V. CONCLUSION

On the basis of the above calculations, we can state that electromagnetic waves are harmful for the human body at various distances from transmission towers. Harmfulness increases at shorter distances and higher frequencies. We can also state that on increasing transmission power from the tower and working frequency, the harmfulness of electromagnetic radiation to human body also increases. It clear that the higher generation of transmission is sure to be more harmful than the earlier ones. This is the reason for worldwide opposition from scientific community against 5G & 6G communication system. As the deployment of 5G network continues, it is imperative that we remain vigilant in evaluating the potential risks and benefits, ensure that the drive for innovation does not come at the cost of public well-being.

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Conflict of interest

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REFERENCES

1. Pathak P.P., Kumar V. & Vats R. P. (2003). Harmful electromagnetic environment near transmission tower. Indian Journal of Radio & Space Physics, 32, 238-241.
2. Kumar V., Vats R.P., Goyal S., Kumar S. & Pathak P.P. (2008). Interaction of electromagnetic radiation with human body. Indian Journal of Radio & Space Physics, 37, 131-134.
3. Kumar V., Vats R.P. & Pathak P.P. (2008). Harmful effect of 41 and 202 MHz radiation on some body parts tissues. Indian Journal of Biochemistry & Biophysics, 45, 269-274.
4. Kazaure J.S., Danladi T.A., Ibrahim J., & Ohaibuiro J. (2016). Study on electromagnetic field emission from GSM base station in Nigeria. IQSR Journal of Electronics & Communication Engineering, 11, 83-88.
5. Kumar, S., & Pathak, P. P. (2011). Effect of electromagnetic radiation from mobile phones towers on human body. Indian journal of radio & space physics, 40, 340-342.
6. sTurgut A. & Engiz B. K. (2018). SAR evaluation due to exposure from base stations operating at 900 MHz and 1800 MHz. 26th Telecommunications Forum (TELFOR), 420-425.IEEE.
7. Bauer J., O'Mahony C., Muclachy J., Silien C. & Tofail S. A. M. (2019). Thermal effect of mobile phone on human auricle region. Journal of Thermal biology, 79, 56-68.
8. Maduka N. C., Abdulmuminu I. & Ahmad M. U. (2019). Assessment of human exposure to non-ionizing radiation emitted from mobile phone base stations in Gusau, Zamfara state. International Journal of Innovative Science Engineering and Technology, 6, 98-109.
9. Christopher B., Khandaker M. U., Sheena Mary Y. & Jojo, P. J. (2020). Empirical study on specific absorption rate of head tissues due to induced heating of 4G cell phone radiation. Radiation Physics and Chemistry, 178, 108910.
10. Roy K., Dey P., Tewary J. & Parui S.K. (2022). Electromagnetic radiation exposure from mobile cell phone decice to its vicinity A study. ICTACT Journal on Communication Technology, 13, 2741-2747.
11. Baliah J., Subramanian B., Livingstone D., Kanwal B., Zaman M.U., Srivastava K.C., Abutayyem H., Al-Johani K., David A. P., Shrivastava D. & Alam M. K. (2022). Comparative analysis of electric field strength, magnetic field strength and power density around the cell phone towers of varying characteristics with a proposed classification facilitating research on human population. International Journal of Environmental Research and Public Health, 19, 14157.
12. Akyildiz I. F., Kak A. & Nie S. (2020). 6g and beyond: The future of wireless communications systems. IEEE Access, 8, 133995–134030.
13. Markov, M., Mobile communications and public health, CRC Press, 2019.
14. Wu T., Rappaport, T., & Collins C., (2015). Safe for generations to come: considerations of safety for millimeter waves in wireless communications. IEEE Microw. Mag., 16, 65-84.
15. Hirata A., Kodera S., Sasaki K., Gomez-Tames J., Laakso I.., Wood A., Watanabe S., & Foster K. R. (2021). Human exposure to radiofrequency energy above 6 GHz: Review of computational dosimetry studies. Phys. Med. Biol., 66, 08TR01.
16. Liu, K.C., & Leu, J. S. (2023). Heat transfer analysis for tissue with surface heat flux based on the non-linearized form of the three-phase-lag model. J. Therm. Biol. 112, 103436.
17. Ishihara, T., Yamazaki, K., Araki, A., Teraoka, Y., Tamura, N., Hikage, T., Omiya, M., Mizuta, M. and Kishi, R., (2020). Exposure to radiofrequency electromagnetic field in the high-frequency band and cognitive function in children and adolescents: a literature review. International Journal of

Environmental Research and Public Health, 17, 9179.

18. Xu B., Colombi D., Törnevik C., Ghasemifard F. & Chen J. (2021). On Actual Maximum Exposure From 5G Multicolumn Radio Base Station Antennas for Electromagnetic Field Compliance Assessment. IEEE Trans. Electromagn. Compat., 63, 1680–1689.
19. Sofri T., Rahim H. A., Abdulmalek M., Abd Rani K., Omar M. H., Yasin M. N. M. & Soh P. J. (2021). Health effects of 5G base station exposure: a systematic review. IEEE Access, 10, 41639-41656.
20. Kostoff R. N., Heroux P., Aschner M. & Tsatsakis A. (2020). Adverse health effects of 5G mobile networking technology under real-life conditions. Toxicology Letters, 323, 35-40.
21. Samaras T., Kuster N. (2019). Theoretical evaluation of the power transmitted to the body as a function of angle of incidence and polarization at frequencies >6 GHz and its relevance for standardization. Bio electromagnetics, 40, 136–139.
22. Wang Y.Z., Li M.J., & Liu D. (2021). Thermo-mechanical interaction on transient heating of skin tissue with variable thermal material properties. Eur. J. Mech. A Solids 86, 104173.
23. Christ A., Samaras T., Neufeld E., & Kuster N. (2020). RF-induced temperature increases in a stratified model of the skin for plane-wave exposure at 6–100 GHz. Radiat. Prot. Dosim. 188, 350–360.
24. Li K., Sasaki K., Watanabe S. & Shirai H. (2019). Relationship between power density and surface temperature elevation for human skin exposure to electromagnetic waves with oblique incidence angle from 6 GHz to 1 THz. Phys. Med. Biol., 64, 065016.
25. Bonato, M., Dossi, L., Gallucci, S., Benini, M., Tognola, G., & Parazzini, M. (2022). Assessment of human exposure levels due to mobile phone antennas in 5G networks. International Journal of Environmental Research and Public Health, 19, 1546.
26. International commission on non-ionizing radiation protection (ICNIRP). (2020). Guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz). Health Phys., 118, 483–524.
27. Polk C., Handbook of Biological Effects of Electro-magnetic Fields (edited by C Polk & E Postow CRC Press, Boca Raton USA,1996).
28. Pathak P. P., Kumar S. & Kumar V., (2008). XXIX General Assembly of the International Union of Radio Science Chicago IL, USA,
29. Adair E. R. & Peterson R. C., (2002) IEEE Trans Micro Theory Technology, 50, 953.
30. World Health Organization (WHO), Research Agenda for Radiofrequency Fields.
31. Federal Communications Commission (FCC) OET bulletin 65, evaluating compliance with FCC guidelines for human exposure to radiofrequency electromagnetic fields, edition Dec (1997).
32. International Commission on Non-Ionizing Radiation Protection (ICNIRP) Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz). Health Physics, 74, 494 (1998).
33. The Institute of Electrical and Electronics Engineers (IEEE), Safety issues associated with base station used for personal wireless communication, 110 (2001).
34. National Council on Radiation Protection and measurement (NCRP), Biological effects and exposure criteria for radio frequency electromagnetic fields, Maryland (1986).
35. Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), Radiation Protection Standard: Maximum Exposure levels to Radio Frequency Field (3 kHz-300 GHz), May 2002).