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PROBABLE EFFECT OF COMMUNICATION TOWERS ELECTROMAGNETIC WAVES ON NEARBY AREAS RESIDENTS DNA INTEGRITY

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ABSTRACT

Due to the frequent use of the Internet all over the world, therefore, researchers efforts must be focused on understanding the basic biological changes that can be caused by electromagnetic radiation emitted from the communication towers, to identify its most important risks and try to develop prevention, diagnosis and treatment strategies for the diseases that may be caused by their effect. One hundred people participated in this study, 70 of them were selected from the residents of the areas near the communication towers. The study extended from September 2022 to February 2023. In addition, 30 people participated as a control group who live far from the areas of construction of these towers. The ages of the participants in this study ranged from 20 to 60 years. All participants in the study were given a questionnaire about the age, gender of the participant, the diseases they suffers from, and the hours they use the Internet. Venous blood samples were collected from all participants to assess serum level of 8-OHdG using ELISA technology. The level of DNA damage was evaluated with respect to 8-OHdG and the results showed a higher level in subjects (3.9) while in the control group it was 0.46.

Key words: Electromagnetic radiation, DNA damage, Communication towers, ELISA, Blood.

التأثير المحتمل للموجات الكهرومغناطيسية لأبراج الاتصالات على سلامة الحمض النووي لسكان المناطق المجاورة

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نظراً لكثرة استخدام الإنترنت في جميع أنحاء العالم، لذلك يجب تركيز جهود الباحثين على فهم التغيرات البيولوجية الأساسية التي يمكن أن تسببها الإشعاعات الكهرومغناطيسية المنبعثة من أبراج الاتصالات، للتعرف على أهم مخاطرها ومحاولة تطوير الوقاية منها, واستراتيجيات التشخيص والعلاج للأمراض التي قد تنتج عن تأثيرها. شارك في هذه الدراسة مائة شخص، تم اختيار 70 منهم من سكان المناطق القريبة من أبراج الاتصالات. امتدت الدراسة من ايلول 2022 لغاية شباط 2023. بالإضافة إلى ذلك، شارك 30 شخصًا كمجموعة سيطرة يعيشون بعيدًا عن مناطق بناء هذه الأبراج. وتراوحت أعمار المشاركين في هذه الدراسة بين 20 إلى 60 عاما. تم إعطاء جميع المشاركين في الدراسة استبيانًا حول عمر المشارك وجنسه والأمراض التي يعاني منها وساعات استخدام الإنترنت. تم جمع عينات الدم الوريدية من جميع المشاركين لتقييم مستوى المصل 8-OHdG باستخدام تقنية ELISA تم تقييم مستوى تلف الحمض النووي فيما يتعلق ب 8-OHdG وأظهرت النتائج مستوى أعلى لدى المرضى (3.9) بينما كان في مجموعة السيطرة 0.46.

الكلمات المفتاحية: الاشعة الكهرومغناطيسية، عطب الدنا، ابراج الاتصالات، الاليزا، الدم.

INTRODUCTION

Over the past few decades, arguments terminated the biotic consequences of electromagnetic fields (EMFs) in scientific works and mass media have been prompted by argumentative and frequently contradicting scientific research. This can produce uncertainty and diversion, which would impair the ability to reach a clear consensus regarding the true risks that EMFs pose to people. For instance, numerous studies have found that EMF can cause DNA strand breakage and death in cells **(Saliev *et al*., 2019)**. In the 1950s, Soviet scientists revealed a syndrome of microwave sickness., Weariness, visual dysfunction, dizziness, Headache and sleep disturbances were among the symptoms .Dermographism, malignancies, blood abnormalities, and reproductive problems were the most common clinical symptoms, as well as cardiovascular problems, sadness, irritability, and memory loss. American studies found similar findings later in the 1970s. The electromagnetic radiation (EMR) emitted by modern cellular towers is primarily made up of high-frequency radio waves or microwaves **(Siddoo-Atwal, 2018)**. Reactive molecules called free radicals are produced when food is converted to energy using oxygen **(Lobo *et al*., 2010)**. Since oxygen is vital to life, it's impossible to prevent the generation of free radicals within the body. However, external factors like microwave radiation can cause the overproduction of free radicals by altering gene transcription and translation through the epidermal growth factor receptor **(Kıvrak *et al*., 2017)**. Ionizing radiation represents one of the hazardous and carcinogenic variables that can have both direct and indirect long-term effects depending on the dose and duration of exposure **(Mohammed & Lafta, 2022)**. The Fenton reaction, a process that converts hydrogen peroxide into harmful hydroxyl free radicals, is well-known, and numerous studies suggest that microwave radiation can promote free radical activity in cells through this mechanism. High levels of ROS produced by microwave radiation may damage brain cells by altering the activity or DNA of biomolecules in the brain that react with the free radicals produced by the radiation **(Lai & Singh, 2004)**. This is an environmental pollution, which is one of the most important problems in the world. It has recently increased with the advancement of industries and the increasing population density **(Mahmood *et al*., 2014; Ahmed *et al*. 2021)**.

Ethics approval

The current work was set to assess the probable effect of electromagnetic waves of communication towers on DNA damage in nearby areas residents in comparison to healthy controls. The study design was accepted by The Research Ethical Committee and Scientific Committee designated by Biology Department, College of Science, University of Baghdad under the reference number of NO: CSEC/0523/004.

METHODS

Study site: Six sites were included in this study in Baghdad/Iraq:

First tower: The first tower was located in Al-Jihad neighborhood, opposite Baghdad College High School, a large station. The tower radiation measured as 0.0184 mW/ cm^2. The tower point was 33.280842, 44.291528.

Second tower: The second tower in Alsaidya Near Al Rayyan Markets. Large station 0.016 maw/cm2. The Location number Map for 33.256591 44.364422 location.

Third tower: Third tower in Al-Byaa. The tower measures 0.019. A small station. The location is 33.267923 44.343104 a small station.

Fourth tower: The site of fourth tower in Al-Mansour, Princesses Street, in front of the Shooting Club 0.018. A large station (33.3143617, 44.3466645).

Fifth tower: Fifth tower in Al- Qadisiyah radiation measurement 0.02164, Location (33.2816310, 44.3538820).

Sixth tower: In Al-Qadisiyah, Al- Nisour Radiant tower 0.0203. A small station. Location 33.2984500, 44.3574410. Figure (1) clarifies the sites in Baghdad.

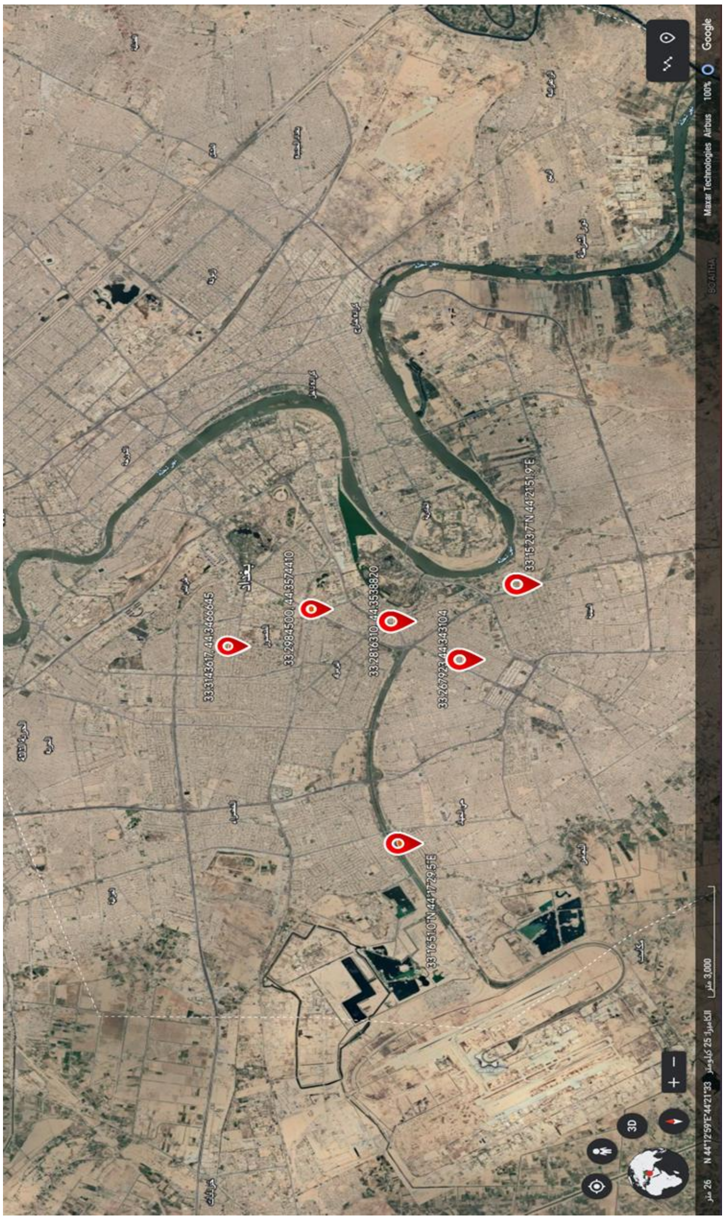

Figure (1): Study sites in Baghdad/Iraq **(Google earth 2023).**

Collection of Samples

Residents and controls blood samples were collected by venipuncture, 5ml of blood was drawn using disposable syringes. The blood was placed in gel disposable tubes. Sera were separated by centrifugation for 5 min at 3000 round per min (rpm). The separated serum was transferred to Eppendorf tube and kept at -20Cº until assayed, and then tube had frozen at -20ºC until DNA extraction for detecting of DNA damage.

Detection of 8-Hydroxydeoxyguanosine (8-OHdG)
Principle of the test

The competitive inhibition enzyme immunoassay approach was used in this assay. A microplate has been pre-coated with a monoclonal antibody specific for 8-OHdG (Cloud-coper/USA). With the pre-coated antibody specific to 8-OHdG, a competitive inhibitory process was initiated between biotin labeled 8-OHdG and unlabeled 8-OHdG (Standards or samples). The unbound conjugate was rinsed away after incubation. Each microplate well was then treated with avidin coupled to Horseradish Peroxidase (HRP). The quantity of 8-OHdG in the sample determines the amount of bound HRP conjugate. The intensity of the color formed after the addition of the substrate solution is inversely proportional to the concentration of 8-OHdG in the sample.

Detection Range of 8-OHdG

The detection range is 74.07-6,000pg/mL. The ELISA standard curve concentrations were 6,000pg/mL, 2,000pg/mL, 666.67pg/mL, 222.22pg/mL, and 74.07pg/mL.

Procedure of 8-OHdG detection test

The standard, blank, and sample wells were diluted, prepared with 50µL each of the standard, blank, and samples, and prepared for standard points and blank points. 50µL of Detection Reagent A was added to each well, shaken, covered, and incubated for 1 hour at 37ºC. If it appeared cloudy, it has been warmed to room temperature and gently mixed until the solution appears uniform. The solution was aspirated, each well was washed with 350µL of 1X Wash Solution, and the remaining liquid was removed. The plate was then inverted and blotted against absorbent paper. Each well was added with 100µL of Detection Reagent B working solution. It was then incubated for 30 min at 37ºC after being covered with the Plate sealer. Then the aspiration/wash process was repeated a total of 5 times. Substrate Solution was added to each well, covered with a plate sealer, and incubated at 37ºC for 10-20 min, ensuring protection from light. 50µL of Stop Solution was added to each well, causing the liquid to turn yellow. Mixing was done by tapping the plate side, ensuring uniform color change. Any drop of water and fingerprint on the bottom of the plate was removed. The liquid was tested for bubbles, then a microplate reader was used for immediate 450nm measurement. Calibration curve was constructed to calculate the concentration of samples as illustrated in (figure 2).

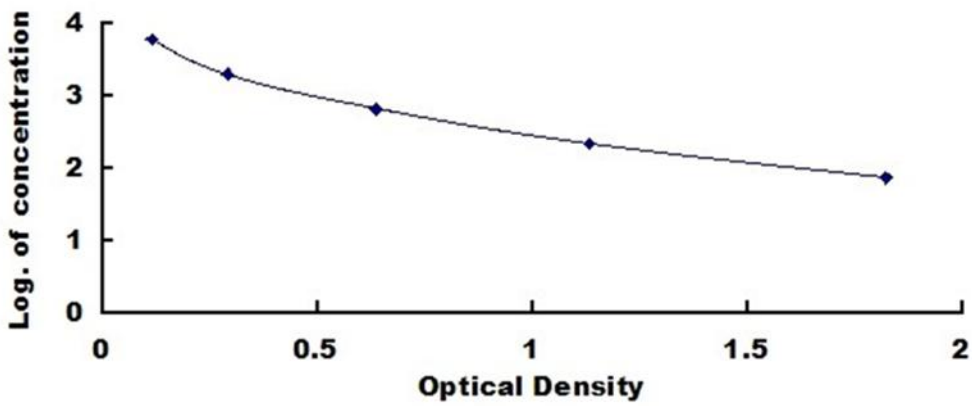

Figure (2): Typical Standard Curve for 8-OHdG ELISA.

Statistical Analysis

The statistical analysis of this prospective study were done using the statistical package for social sciences (SPSS) 21.0 and Microsoft Excel 2013. Numerical data were described as mean and standard deviation. Categorical data presented as count and percentage, Chi—square used for describe the association between variables. The lower level of accepted statistical significant difference is equal or bellow to 0.05.

RESULTS

The distribution of subjects according to their date of the construction of the communication tower was as: 35 subjects (50%) were lived in area with established communication tower since 2007, 25 (36%) since 2012 and 10 (14%) since 2010 (Figure 3).

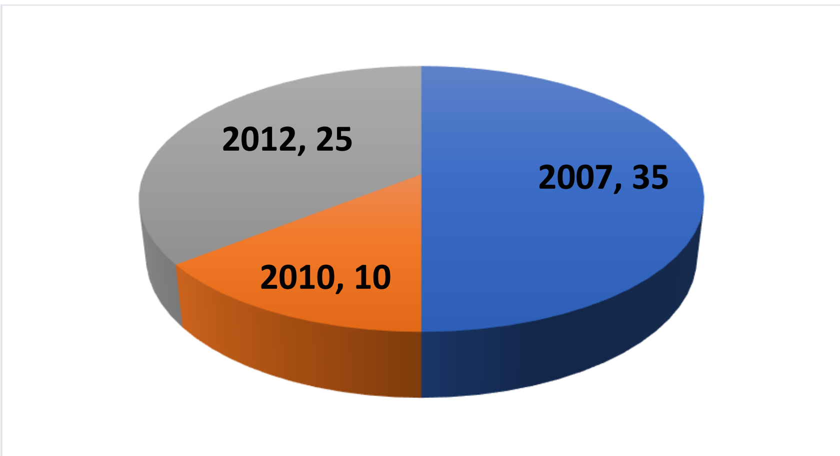

Figure (3): Distribution of subjects according to their date of the construction of the communication tower.

The radiation of the tower was measured in each area (mW/CM^2v) were ranged from 0.016 – 0.02164 mW/CM^2v as shown in figure (4).

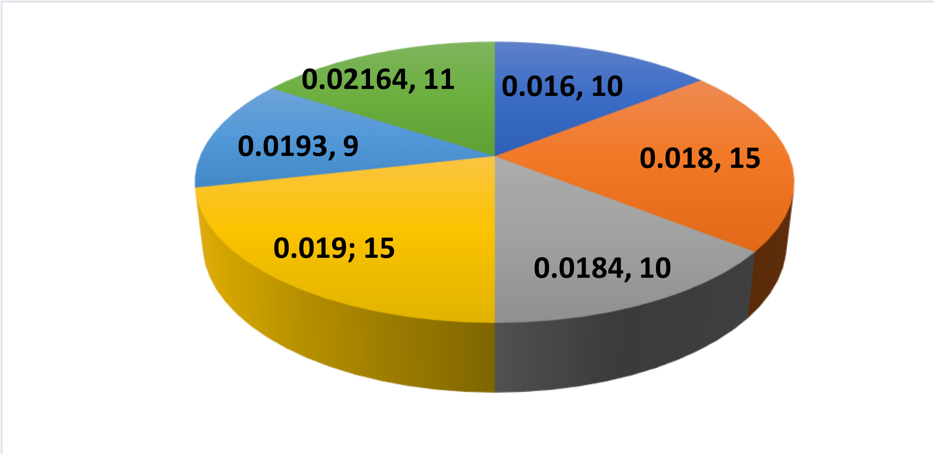

Figure (4): Distribution of subjects according to the radiation of the tower: 15 subjects at 0.019 mW/CM^2v, 15 subjects at 0.018 mW/CM^2v, 11 subjects at 0.02164 mW/CM^2v, 10 subjects at 0.0184 mW/CM^2v, 10 subjects at 0.016 & 9 subjects at 0.0193 mW/CM^2v.

DNA damage

The level of DNA damage was measured depending on level of 8-hydroxdeoxyguanosin in both study groups. The results of this study showed that there was a high statistical significance in its mean in which subjects group have higher level (3.9) compared with control group (0.46) (Table 1, Figure 5).

Table (1): Descriptive analysis of 8-OHdG between study groups.

		Study groups	
		Control	**Subjects**
8-OHdG (ng/ml)	Mean	0.46	3.79
	Standard Deviation	0.14	2.19
P value		<0.001**	

**: high statistical significance (p<0.001).

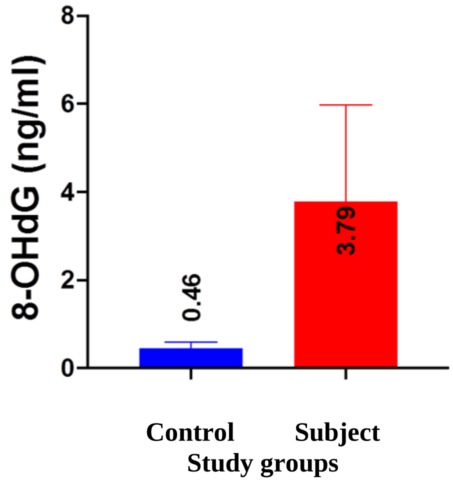

Figure (5): Mean 8-OHdG in study groups.

Based on the data presented, it may be concluded that there is a statistically significant difference in 8-OHdG levels between the control and subject groups. The higher mean and standard deviation values in the subjects group compared to the control group indicate a higher concentration and variability of 8-OHdG in the subjects group.

In a study investigating the effects of ionizing radiation on 8-OHdG, it was shown that subjects had much greater levels of 8-OHdG than controls did, according. This conclusion was strengthened by the discovery that 8-OHdG levels were strongly linked with subject ages and the length of time they had been exposed to oxidative stress. Subjects average blood 8-OHdG levels were (131.42 ng/mL) (P 0.001) higher than those of the controls **(Gao *et al*., 2019)**.

Humans experience oxidative stress due to both internal and environmental influences, such as parasite infections that upset the antioxidant balance. Nutrition and antioxidants both help to prevent this stress **(Harvey *et al*., 2015; Hamdia & Ahamed, 2023).** Even the dietary habits affect the oxidants level, such as consuming canned foods **(Alsoufi, 2022)**.

An epidemiological study was done to investigate the relationship between asbestos exposure and 8-OHdG. The greatest levels of 8-OHdG were closely correlated with the length of time subjects had been subjected to oxidative stress, further supporting the finding that 8-OHdG levels in subjects were greater than in healthy controls. In comparison to healthy controls, the mean 8-OHdG levels in subjects were substantially higher (P = 0.001) than those in healthy controls. Increased 8-OHdG concentrations are a sign of oxidative DNA damage **(Cellai *et al*., 2020)**.

Association of sex with DNA damage marker

The impact of sex in the DNA damage marker was depended. The results showed that DNA damage marker was not significant between male and females (p=0.631) (Figure 6, Table 2).

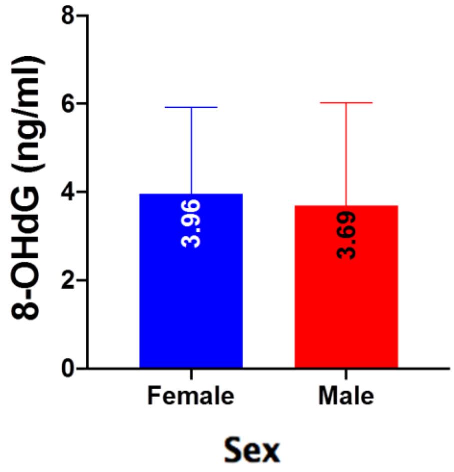

Figure (6): Mean DNA damage marker according to sex of subjects.

Table (2): Association of DNA damage marker with sex of subjects.

	Sex		P value
	Female	Male	
8-OHdG (ng/ml)	3.96±1.95	3.69±2.33	0.631^{NS}

The symptoms described by 420 participants (205 men and 215 women) who lived between 10 meters and 300 meters from cell phone towers were examined in an earlier study on the impact of sex. Men present with fewer symptoms than women, according to studies. According to **Santini *et al*. (2003)**, seven symptoms, headaches, suicidal thoughts, nausea, disturbed sleep, appetite loss, vision issues, and an overall feeling of discomfort were much more severe in women than in men.

Association of establishment date of tower with DNA damage marker

The results obtained by this work showed that the p-value is near to the threshold of significance, but there is no statistically significant variation in 8-OHdG levels for towers built in different years Regarding DNA damage marker didn't show a statistical difference according to the date of establishment of tower (p=0.072) (Figure7, Table 3).

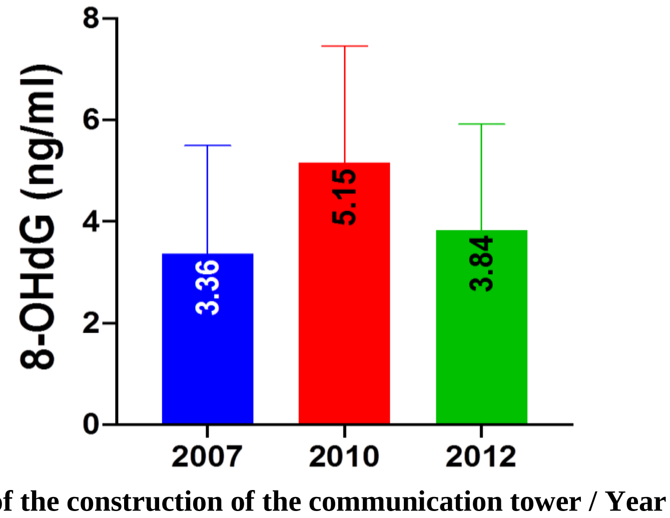

Figure (7): Mean DNA damage according to tower establishment date among subjects.

Table (3): Association of DNA damage with date of tower establishment use.

	Date of establishment of tower			**p value**
	2007	2010	2012	
8-OHdG (ng/ml)	3.36±2.13	5.15±2.31	3.84±2.07	0.072 NS

Association of measure of radiation with DNA damage marker

The results of this study showed that DNA damage marker showed a statistical difference according to the radiation (p=0.019) eventhough high level of DNA damage marker was found in low measure of radiation but high level of DNA damage marker was found in high measure of radiation (Figure 8, Table 4).

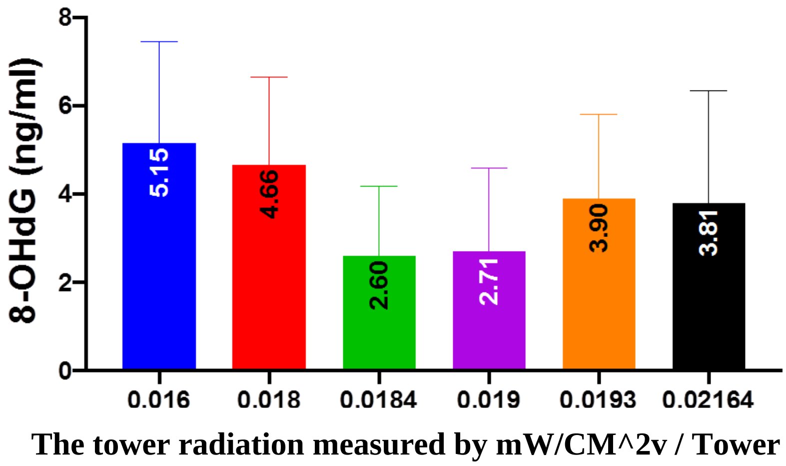

Figure (8): Mean DNA damage according to measure of radiation among subjects.

Table (4): Association of biochemical parameters with measure of radiation.

Measure of radiation	8-OHdG (ng/ml)
0.016	5.15±2.31
0.018	4.66±1.99
0.0184	2.60±1.57
0.019	2.71±1.89
0.0193	3.90±1.92
0.02164	3.81±2.53
p value	0.019*

According to studies, being exposed to low-intensity electromagnetic waves can lead to structural changes in the DNA molecule as well as oxidative stress. These findings suggest that prolonged exposure of the animals to RF-EMF-induced oxidative stress can result in DNA damage in neurons. Several further investigations **(Hussein *et al*., 2016**; **Sahin *et al*., 2016**; **Sharma & Shukla, 2020)**, likewise produced very identical findings. The 8-OHdg biomarker, which shows DNA damage by attack free radicals, increased as a result of the formation and binding of certain free radicals to the DNA molecule. Following a pairing of organic DNA bases with this biomarker, mutation in this molecule can also take place and be passed down from generation to generation **(Valavanidis *et al*., 2009; Schuermann & Mevissen, 2021)**. DNA may be affected by other factors such as therapy **(Alwan *et al*., 2016)**.

The level of 8-OHdG can be influenced by a variety of confounding factors, including age, sex, and smoking behaviors. According to smoking evaluations, irradiated workers who smoked had higher 8-OHdG levels than irradiated individuals who did not smoke **(Mrdjanovic *et al*., 2020)**. On the other hand, according to another study, there were no significant differences in smoking habits or gender across the groups. Since the majority of the study participants were hospitalized for their treatment, they were fed a standard hospital meal, which made nutrition unlikely to be a confounding factor **(Erhola *et al*., 1997)**. In contrast, a previous study identified smoking as the most significant component in 8-OHdG urine excretion and identified body mass index, sex, and smoking as critical drivers of 8-OHdG urinary excretion **(Loft *et al*., 1992)**.

In a previous study found that mobile phone radiation exposure at frequencies of 900, 1800, and 2100 MHz may cause oxidative damage, increased lipid peroxidation, and DNA damage in rats. The specific absorption rates at the brain were 0.0845 W/kg, 0.04563 W/kg, and 0.03957 W/kg, respectively **(Alkis *et al*., 2019)**.

High frequency EMF's potential to trigger DNA breakage was examined by Franzelletti and colleagues **(Franzellitti *et al*., 2010)**. The authors exposed trophoblast cells (HTR-8/SVneo) to various GSM (mobile phone standard) frequencies as well as a 1.8 GHz continuouswave EMF. It was discovered that high frequency EMF leads to momentary increases in DNA fragmentation (the breaking up of DNA strands). **Lasalvia *et al*. (2018)** used a comparable frequency (1.8 GHz) to show the viability of biochemical changes in human peripheral blood lympho-monocytes exposed to radio frequency EMF, including a decrease in the DNA backbone-linked vibrational modes.

The GC-2 cell line generated from mouse spermatocytes was the subject of a study by Duan and colleagues to determine the possible genotoxicity of 50 Hz extremely low-frequency EMF and 1800 MHz radiofrequency EMF **(Duan *et al*., 2015)**.

The results revealed that cells exposed to extremely low-frequency EMF saw a considerable increase in DNA strand breakage. The researchers also found that exposure to radiofrequency EMF significantly increased the amount of oxidative DNA base damage (SAR 4W/kg). On the other hand, very low-frequency EMF radiation was unable to achieve the same effects. It suggests that at relatively high levels, both classes of EM frequencies may be genotoxic **(Saliev *et al*., 2019)**. According to a local study, being exposed to ionizing radiation increases DNA damage **(Al-Jameel *et al*., 2019)**.

CONCLUSIONS

The principle conclusion of this research was a significant difference in the levels of 8-OHdG between the two groups. Participants who lived near communication towers had a significantly higher mean amount of 8-OHdG (3.9) in their serum, indicating a potentially increased level of DNA damage. In contrast, the control group, which included people who lived far away from the towers, had a much lower mean level of 8-OHdG (0.46). These findings point to a possible link between closeness to communication towers and an increased sensitivity to DNA damage, as evidenced by greater 8-OHdG levels. While these findings give important information about the possible effects of communication towers on DNA integrity, more research is needed to establish causal linkages and identify underlying processes. These findings may have consequences for the siting of communication infrastructure in residential areas, as well as the possible health hazards associated with chronic exposure. Overall, this work adds to the growing body of knowledge about the potential effects of electromagnetic fields on human health, highlighting the significance of further research into the potential implications of modern advances in technology.

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