**Estimation of some antioxidants for people exposed to electromagnetic waves for Internet towers in Samarra**

**Methaq Nazhan Mahmood 1 , Asmaa Hashim Shaker 2 , Humam E. Mohammed 3**

1Department of Applied Chemistry, College of Applied Science, University of Samarra, Samarra-Iraq

2Department of Chemistry, College of Education for Women , University of Tikrit ,Tikrit -Iraq

3Department.of.Pathological.Analyzes, College.of Applied Sciences, University of Samarra-Iraq.

\*Corresponding Author: Charter61@uosamarra.edu.iq

dr.asmaa@tu.edu.iq

Humam.ezzat36@uosamarra.edu.iq

**Abstract**

 The current study was conducted in Samarra city, as a preliminary study to explore the impact of the presence of Internet network towers inside cities and on residential homes and its impact on people exposed directly and indirectly. The study included collecting samples from people exposed to the radioactive frequencies of Internet towers for periods ranging from (1-5) years and from (5- 10) years. The number of samples was 43 samples of females and males exposed (present in the places where the constellations are located), and 20 samples not exposed (in places far from the towers) as a control group, and the ages ranged between (20-35) years. Analysis and measurements were made for some antioxidants because it is one of the most essential lines of defense against free radicals that cause many diseases and premature aging, which included the concentration of the enzyme glutathione peroxidase PGx, the enzyme superoxide dismutase SOD, glutathione GSH, dimalondhyde MDA, and ONOO. The results showed a significant increase in the level of glutathione peroxidase enzyme concentration and the concentration of superoxide dismutase in the blood serum for people exposed to electromagnetic waves from the Internet towers compared to the control group. The results also showed a significant decrease in the level of GSH in the blood serums of people exposed to electromagnetic waves of the Internet towers compared to the control group. The results also showed a significant increase in the concentration of both MDA and peroxynitrite ONOO compared to the non-exposed subjects in the control group.

**Keywords:** antioxidants; electromagnetic waves; Internet towers; Samarra

**Introduction**

 With the development of life and its complexities and the expansion of the circle of scientific progress and inventions that made to serve the human being, it was necessary to study the effects and reflections of some of these advances negatively on nature and people, So, we mention the extraordinary achievement that came from the invention of devices that work with electromagnetic waves, which provided prominent services for humans, However, this scientific progress in energy and communication has drawbacks that may directly or indirectly affect human health.**(1)**Visible light, microwaves, x-rays, gamma, television and radio are known electromagnetic rays and they all have the same properties but differ in wavelength and frequency, Electromagnetic fields consist of an electric field and a magnetic field perpendicular to each other, these fields are described in terms of magnitude and direction, Electromagnetic waves are made of vibrating electric and magnetic fields and they interact directly with biological systems such as human cells, animals, and plants**.(1)**Electromagnetic waves can cause biological effects that can sometimes but not always lead to harmful health effects**.(2)** The biological effect may occur when exposure to electromagnetic waves causes significant or detectable physiological changes in the biological system, the harmful effect on health occurs when the biological effect is outside the body’s ability to resist which leads to some harmful health conditions**.(2)**When studying the mutual effect between electromagnetic fields in general and the surfaces exposed to them, we use the concept of power density, which is estimated in watts per square meter [w/m2], that inversely proportional to the square of the distance between the source and the receiving surface, the flowing power takes its highest value near to the antenna and decreases as we move away from it so that the strength of the electromagnetic field is inversely proportional to the square dimension.**(4,3)**On the biological side the interaction of the electromagnetic fields with the living medium varies according to the frequency used and the biological nature of the exposed medium, several studies have shown that electromagnetic fields have different effects, at a particular strength exposure to these fields can lead to burns, and the eye may be injured when exposed to visual cataracts chemical and biological changes can occur in the body.**(5)** It should be noted that the path depth of electromagnetic fields inside a living body decreases with increasing frequency, to understand the mechanism of mutual influence between electromagnetic fields and the body, we must consider the distinction between the various parts of the body in their structural and electrical properties, the effect of the electromagnetic field varies according to the frequency, there must be ions or substances of a polar nature in the exposed medium to make the effect in addition to materials that have magnetic features that make them more sensitive to the applied external field, such as some iron oxides, the presence of ions inside the exposed body increases the mutual effect between the applied electromagnetic field and the medium and the rate of the specific energy absorbed**.(6)** Some studies have indicated that these waves have a thermal and biological effect that causes insomnia, headache, and temporary memory loss, and these effects depend on the frequency of the waves and the amount of energy absorbed within the tissues of the body in addition to the length of the period of exposure to these waves.**(7)** Other recent studies have shown that the electromagnetism presence contributes to the development of free radicals inside the cell by disrupting the action of natural antioxidants.**(6,8)**

**Materials and Methods**

**Samples Collection**

The current study was conducted in Samarra city, and a survey was conducted on the number of Internet network stations in Samarra city. A questionnaire was conducted by persons exposed to the radioactive frequencies of the Internet towers. The questionnaire included name, age, gender, and exposure period. Samples were taken from people without chronic diseases to avoid interference with the results of the research. Samples were collected from people exposed to the radiation frequencies of the net towers for (1-5 and 5-10) years. Forty-three exposed females and males were collected, and 20 non-exposed samples were collected. The ages ranged between 20-35 years.

A disposable syringe was used to take 5 ml of blood from each individual, and after each time, the blood samples were placed in a gel tube, anticoagulants free. The samples were centrifuged at 3500 rpm for 10 minutes to obtain blood serum. Then the serum was divided into five parts using small independent tubes, samples

were kept in boxes and stored at the degree of freezing until the biochemical tests for the antioxidants**.(9, 10, 11, 12)**

**Statistical Analysis:**

 The mean and standard deviation were calculated among the groups, and a t-test was adopted to compare the results between the groups.**(12)**

**Results and Discussion Data Description**

After collecting the data and making sure of its accuracy and entering it into the program (t-test), data were put in common statistical tables to describe this data or highlight one or more feature either in simple or double frequency tables and represent these data graphically that fits with the type of data and calculate some statistical measures that highlight a character or more in the data. The frequencies and percentage of all variables were obtained according to the following tables.

**Gender:**

Table (1) shows the distribution of the sample members according to gender, where we notice that (75%) are males, which is the highest, and that the percentage of females (43%) is the lowest.

**Table (1) Distribution of the sample members by gender**

|  |  |  |
| --- | --- | --- |
| **Percentage%** | **Frequencies** | **Gender** |
| 57 | 24 | Males |
| 43 | 18 | Females |
| 100 | 42 | Total |

To clarify the percentage of males and females of the study sample, a graph of the circular sectors was used as shown in figure (1).

**Figure (1) The percentage of males and females in the study sample**

**Age:**

Table (2) shows the distribution of the sample members in the study according to age, where we note that the highest the percentage (34.8%) are from the first category 20-25 years old, and the lowest percentage (27.9%) are from the first category 25-30 years old.

**Table (2) Distribution of the sample according to age**

|  |  |  |
| --- | --- | --- |
| **Percentage%** | **the number** | **Age category (years)** |
| 34.8 | 15 | 20-25 |
| 27.9 | 12 | 25-30 |
| 30.2 | 13 | 30-35 |
| 100 | 40 | Total |

To clarify the age distribution of the study sample using the graph as shown in Figure (2).

**Figure (2) the age distribution of the study sample**

**Exposure Period:**

 Table (3) shows the distribution of the samples in the study according to the exposure period, where we notice that the highest 83% in the exposure period (1-5 years) and the lowest percentage 11.6% in the exposure period (5-10 years).

**Table (3) Distribution of the sample according to the exposure period**

|  |  |  |
| --- | --- | --- |
| **Percentage%** | **The number** | **Exposure Period (years)** |
| 83 | 36 | 1-5 |
| 11.6 | 5 | 5-10 |
| 94.6 | 41 | Total |

To clarify the distribution of the exposure period for the study sample using the graph as shown in Figure (3).

**Figure (3) the distribution of the exposure period for the study sample**

**Determination of antioxidants in serum for people exposed to electromagnetic waves of Internet towers.**

Table (4) shows the mean±standard deviation of antioxidant levels represented by biochemical measurements (GPX, SOD, GSH, ONOO, MDA) in the serum of exposed people.

**Table (4) for glutathione peroxidase, SOD, glutathione GSH, peroxynitrite (ONOO), and dimalonaldehyde MDA in serums people of exposed** **to electromagnetic waves.**

|  |  |
| --- | --- |
| **Mean±S.D** | **Antioxidant defense** |
| **exposed**  | **Control**  |
| 4.509±2.035 | 2.724±0.682 | **GPx (U/L)**  |
| 6.260±7.471 | 1.285±0.554 | **SOD(U/L)** |
| 0.0708±0.0451 | 0.081±0.03 | **L) /μmole) GSH** |
| 0.660±0.3081  | 0.360±0.246 | **Peroxy nitrate (μmole⁄ L)** |
| 12.670±3.919 | 2.14±0.804 | **MDA (μmole⁄ L)** |

 **The enzyme Glutathione peroxidase (GPX):**

 The efficacy of GPX glutathione peroxidase was measured in the blood serum of group people exposed to electromagnetic waves by the internet towers and the control group non-exposed people. Then the rate±standard deviation of the mentioned groups was extracted as shown in Table (4) and Figure (4).

**Figure (4) Modifying the activity of the glutathione peroxidase (unit/liter) in the serum of the groups under study.**

 The mean±S.D. of the control group and the exposed group was (2.724± 0.682 units/liter), (4.509±2.035 units/liter), respectively. The results of the current study indicated a significant increase in the concentration of glutathione peroxidase in the serum of subjects exposed to electromagnetic waves by Internet towers compared to the control group of non- exposed people. This result contradicts (Kajal's)**(13)** study that found the enzyme decreases when male rats are exposed to electromagnetic radiation by mobile phones and microwaves 2 hours a day for 35 days.

**The enzyme Superoxide dismutase (SOD):**

The efficacy of the SOD enzyme superoxide dismutase was measured in the serum of group people exposed to electromagnetic waves by the internet towers and the control group non-exposed. The mean±standard deviation of the mentioned groups was extracted as shown in Table (4) and Figure (5).

**Figure (5) the activity of SOD superoxide dismutase enzyme (unit/liter) in the serum of the studied groups.**

The mean±standard deviation (mean±S.D) of the control group and the exposed group was (1.285±0.554 units/liter), (6.260±7.471 units/liter) respectively. The results of the current study indicated a significant increase in the concentration of the superoxide dismutase enzyme in the serum of people exposed to electromagnetic waves by Internet towers compared to the control group for non-exposed people. These results contradict the findings by ( Kajal)**(13)** and ( Sepehrimanesh). He studied the effect of the magnetic field 900 megahertz of electromagnetic field  (EMF) on mice serum, after measuring the antioxidant enzymes 30 days after exposure observed decreased both GPx and SOD activity.**(14)**

**Glutathione GSH Reduced:**

The concentration of GSH glutathione was measured in the serum of the control group non-exposed people and the group of people exposed to electromagnetic waves by the Internet towers. The mean±standard deviation of the mentioned groups was extracted as shown in Table (4) and Figure (6).

**Figure (6) Glutathione Levels (mM/L) in the serum of the understudy groups.**

The mean±SD of the control group and the exposed group were (0.081± 0.03 micromole/liter), (0.0708±0.0451 micromole/liter), respectively. The results of the current study showed a significant decrease in the level of GSH in serum of people exposed to electromagnetic waves by Internet towers compared to the control group of non-exposed people. The results of the current study agree with (Arendash)**(15)** and (Meral)**(16)** as exposure to electromagnetic fields led to a decrease in the level of glutathione GHS in mice and guinea pigs.

**Peroxy Nitrate (ONOO):**

 The concentration of peroxynitrite (ONOO) was measured in the serum of people exposed to electromagnetic waves by Internet towers and the control group non-exposed people. The average±standard deviation of the mentioned groups was extracted, as shown in Table (4) and Figure (7).

**Figure (7) The levels of Peroxynitrite (mM/L) in the serum of the groups under study.**

The mean±SD of the control group and the exposed group was (0.3605±0.246 micromole/liter), (0.6603±0.3081 micromole/liter) respectively. The enzyme increased in the serum of subjects exposed to electromagnetic waves by Internet towers compared to the control group of persons not exposed. (Kivra) have proven that exposure to electromagnetic fields, similar to other stress factors, leads to oxidative stress, as he observed, through his studies, an increase in lipid and protein oxidativation in different tissues, in addition to significant changes in levels of antioxidants such as Glutathione, GSH, Glutathione Peroxidase GPx, and Supraoxide SOD dismutase and Catalase CAT. **(17)**

**The concentration of Malondialdehyde MDA**:

 The concentration of MDA was measured in the serum group of exposed people and the control group non-exposed people. The mean±standard deviation of the mentioned groups was extracted, as shown in Table (4) and Figure (8).

**Figure (8) the levels of malondialdehyde (mM/L) in the serum of the groups under study.**

 The mean±S.D. of the control group and the exposed group were (2.14±0.804 micromole/L), (12.670±3.919micromole/L), respectively. The results of the current study showed that there was a significant increase in the concentration of malondialdehyde in the serum of people exposed to electromagnetic waves by Internet towers compared to the control group for non-exposed people. These results are consistent with the findings of (Kajal).**(13)** He noticed an increase in the MDA level efficacy when male rats were exposed to electromagnetic radiation by mobile phones and microwave devices 2 hours a day for 35 days. Another study by (Ghanbari) showed that after 50 days of exposure to electromagnetic field (EMF) caused oxidative stress by increasing MDA levels and GPx glutathione peroxidase activity and decreasing SOD activity**.(18)**

 Numerous studies have been conducted related to the non-thermal effects of radiofrequency EMF on biological tissues.**(19)** It has been observed that this effect mediates the generation of reactive oxygen species (ROS).**(20)** ROS participates in various cellular functions that may be necessary or highly toxic to cellular homeostasis. **(21)** Its cytotoxic effects result from the oxidation of phospholipids, which creates a change in membrane conductivity and a loss of cell membrane integrity**.(22)** Several research studies have confirmed that exposure to electromagnetic fields causes an increase in the production of free radicals in the living cell. Living organisms have antioxidant mechanisms such as glutathione, GSH, and glutathione. GPx peroxidase, SOD superoxide dismutase, and CAT catalase. these antagonists work to reduce the damage caused by free radicals ROS

and their products.**(23)** This defense mechanism works by suppressing or blocking chain reactions produced by free radicals. Exposure to a factor that causes excessive production of free radicals ROS, including electromagnetic fields such as EMF, leads to oxidative stress**.(24)** Studies in recent years have indicated that free radicals play a major role in the development of many diseases such as cancer and diabetes.**(25)**

I. Ethical approval:

The manuscript is written in original and all the data, results pertaining to this manuscript are original according to the research performed. The authors followed academic integrity and have not copied any content/results from another source.

II. Funding details (In case of Funding):

The authors of this manuscript did not receive any funding to perform the present research

III. Conflict of interest

The authors of the study do not have any conflict of interest

IV. Informed Consent:

The authors of the manuscript agrees to publish this research in the journal if it’s considerable by the editors of the journal. The authors provide full consent for reviewing and publishing this manuscript.

V. All the authors of this study contributed equally in terms of performing the research as well as in preparing the manuscript. All the authors of the study followed the guidelines of the corresponding author. Any query/suggestion related to the manuscript can be reached to the corresponding author

**Reverences**

1. R. S. Williams, "University Physics", California press:1988.
2. Ahmed Nasser Al-Libi, “Electromagnetic waves and their impact on humans and the environment,” University of Benghazi, Libya: 2004.
3. Independent Expert Group on Mobile Phones, "Mobile Phones and Health", Chairman, Sir William Stewart, Chilton, Oxon OX11 0RQ, April: 2000.
4. PIRARD W, "Champs Electromagnetique a Proximité des ,Antennas-Relais de Mobilophonie", Belgique, Rapport final, Mai :2000.
5. NRPB, "Electromagnetic Field and Risk of Cancer", Report of an Advisory Group on Non Ionizing Radiation, Volume 3, No1:1992.
6. Johnson C.C. Guy A.W., "Non-ionizing electromagnetic wave effects in biological materials and systems", Proceedings of the IEEE, Volume: 60, P. 692- 718: 2005.
7. Hardell, LM .Carlberg, F. So derqvist, and K. Hansson Mild, “Meta-Analysis of Long-Term Mobile Phone Users and the Association with Brain Tumors”. Int.J.Oncology.32:1097-1103:2008.
8. Amara S. et al, "Effect of Static Magnetic Field and Cadmium on Oxidative Stress and DNA damage in Rat cortex Brain and Hippocampus", Journal of Toxically Ind. Health, Vol. 27, pp 99 .106: 2011.
9. Abdel-Razek, A. G. ; Safinaz, M. E.; Shami, H. , AL Mallah, M. and Minar, M. Hassan, M. .Blending of virgin olive oil with less stable oil to strengthen their antioxidative potencies. Australian J. Basic and Applied Sci; 5(10):312-318:2011.
10. Brown, M.; Faust, J. and Goldstein, L. "Role of the low densi-ty lipoprotein receptor in regulating the content of free and esterified cholesterol in human fibroblasts". J. Clin. Invest. 55.p: 783-793:1975.
11. Padmini, E. and Sundari, B. .Erytherocyte glutathione depletion impairs resistance to haemolysis in women consuming alcohol. Clinical Biochemistry Nutriation.42: 14- 20: 2008.
12. Priyadarism, K.I. .Free Radical reaction of curcumin in membrane models .Free Radic Biol. Med*.*;23: 838-843:1997.
13. Kajal Kumari, Ramovatar Meema, Shivendra Kumar, Paulraj Rajamani, Hriday Narayan Verma, Kavindra Kumar Kesari," Radoifrequency electromagnetic field exposure effects on antioxidant enzymes and liver function tests" International Journal of Life Sciences. 1(3)233-239 :2012.
14. Sepehrimanesh M., Nazifi S.,Saeb M., Kazemipour N.,"Effect of 900MHz radiofrequency electromagnetic field exposure on serum and testicular tissue antioxidant enzymes of rat. Olin Journal of Veterinary Research.20(9)24-617:2016.
15. Arendash GW., Sanchez-Ramos J., Mori T.,Mamcarz M., Lin X., Runfeldt M., Cao C., "Electromagnetic field treatment protects against and reverses cognitive impairment in Alzheimer's disease mice. J Alzheimer Dis.19(1);191-210:2010.
16. Meral I., Mert H., Mert N., Deger Y., Yoruk I., Yetkin A., Keskin S., "Effects of 900-MHz electromagnetic field emitted from cellular phone on brain oxidative stress and some vitamin levels of guinea pigs" Brain Res.1169(1);120-124:2007.
17. Kivrak EG.,Yurt KK., Kaplan AA., Alkan I.,Altun G.,"Effects of electromagnetic fields exposure on the antioxidant defense system" J Marcosc. Ultrastructure.5;167-176:2017.
18. Ghanbari A.A.,Shabani K., Mohammad D." protective effects of vitamin E consumption against 3MT electromagnetic field effects on oxidative parameters in substantial Nigra in Rats. "Basic Clinical Neuroscience. 7:22-315:2016.
19. Sepehrimanesh M., Kazemipour N,Saeb M., Nazifi S.,Davis DL. "Proteomic analysis of continuous 900-MHz radiofrequency electromagnetic field exposure in testicular tissue :a rat modle of human cell phonte exposure .Environ Sci. pollut. Res Int.24:73-13666:2017.
20. Tkalec M.,Malaric K.,Pevalek-Kozlina B., "Exposure to radiofrequency radiation induces oxidative stress in Duckweed *Lemna Minor L*. Sci. Total Environ."388;78-89: 2007.
21. Cui K., Luo X.,Xu K., Ven Murthy MR. "Role of oxidative stress in neurodegeneration recent developments in assay methods for oxidative stress and nutraceutical antioxidants. Prog Neuropsychopharmacol Biol Psychiatry.28;99-771:2004.
22. Halliwell B. "Role of free radicals in the neurodegenerative diseases .therapeutic implications for antioxidant treatment, Drugs Aging . 18;685-716:2001.
23. Calcabrini C., Mancini U., De Bellis R., Diaz AR.,Martinelli M.,Cucchiarini L.*et al*. "Effect of extremely low-frequency electromagnetic fields on antioxidant activity in the human keratinocyte cell line NCTC2544. Biotechnol Appl Biochem.64(3);415-422:2017.
24. Halliwell B. "Oxidative stress and cancer :Have we moved forward?" Biochem J.401;1-11:2007.
25. Ames BN.,Shigenaga MK., Hagen TM. ,"Oxidants, antioxidants and the degenerative diseases of aging". P Natl. Acad. Sci. USA.90;22-7915:1993.