Journal of Education for Pure Science
Vol.15, No.2 (2025)
DOI: https://doi.org/10.32792/jeps.v15i2.531
Website: jceps.utq.edu.iq Email: jceps@eps.utq.edu.iq

Physiological changes associated with exposure to mobile phones radiation and home routers in rabbits as experimental model

Rusul D.Mahdi[1,*], Ahmed R. Mathloom[2]

1 Department of Physics, College of Education for Pure Science, Thi Qar University, Nasiriyah, Iraq 64001.

2 Department of Physics, College of Education for Pure Science, Thi Qar University, Nasiriyah, Iraq 64001.

***rusuldhiab. Phsx@utq.edu.iq**

Received 17/8 /2024, Accepted 22 / 9 /2024, Published 1 / 6 /2025

Abstract:

The environment surrounding being organisms is a crucial factor that influences the level of biological exchange of these organisms. Our topic is related to the effect of mobile phones and home routers, were the electromagnetic waves and emitted from it this important on the biological structure of humans and animals. The study is divided into two main parts: the first part discusses the general framework of this effect; the second part focuses on the practical examination of the physiological effects of these waves on blood indicators in rabbits over three months with exposure for 22 hours daily and discusses the mechanisms of these effects. The current study results indicate that the waves emitted by mobile phones and routers have an effect on blood parameters. The results of the statistical analysis from this study indicate significant effects on the studied blood parameters about ($p<0.05$), despite some numerical changes, represented by a decrease in the number of WBC and RBC, In addition to other parameters (MID%, HGB, NEUT%, and LYM%).

Keywords: Electromagnetic Radiation, Blood parameters, Mobile phone, Router.

1-Introduction

In the twenty-first century our life are dealing with varying degrees of access to the data provided by science and technology in most fields, such as transportation, communications, management organization, military and space aspects, as also as chemistry, physics, natural sciences, and biotechnology[1]. Some countries produce this data to consume, export and continuously developing it simultaneously, as they

possess the tools for that, while others are content to follow and observe from afar. Most countries in the world can obtain these technologies from the major companies and benefit from them. The problems facing humanity have increased in this century at varying rates, but there are common issues such as the imbalance of natural ecosystems, ignorance in dealing with natural resources, the problem of population growth, and the issue of radioactive pollution (mobile phones, routers, etc.). For instance, the transfer of industrial technology, without a good understanding of this technology, has led to the occurrence of radioactive pollution in increasing forms and rates[2] .

The topic of pollution by electromagnetic waves (radiative pollution) emitting from mobile phones and routers is broad and complex and includes all aspects of the environment. Radioactive pollution occupies a large space among other types of pollution, and is even the most dangerous[3]. Since radiation knows no boundaries, its effects may not be instantaneous and may not be perceived by all human senses. When a radioactive substance enters the natural environment, we say that the environment has been radioactively contaminated. There is no doubt that electromagnetic waves are neither felt nor seen when they are emitted from electronic devices, especially from the telephone and routers. Many studies have been performed to evaluate the effects of both thermal and non-thermal levels of RF radiation on blood chemistry and blood cell counts[4] . The results indicate that power intensities that produce whole-body SAR of less than 2.5 W/kg do not produce significant changes in blood parameters[5] The results of the Australian Radiation Protection report in 2005 confirmed that 70% of the waves emitted by mobile phones are absorbed in the user's head, which leads to an increase in the speed of nerve impulses, blood pressure, and heart rate as a result of exposure to electromagnetic waves. It leads to circulatory Increased blood flow, disturbed blood pressure, and decreased hemoglobin[6] .

Mobile phones operate by sending and receiving low-power radio signals at a frequency band of 900MHz and 1800MHz. The signals are transmitted and received by antennas connected to wireless transceivers, which are commonly referred to as mobile base stations. The base stations are connected to the rest of the mobile and landline phone networks and pass the signal/call to those networks[7] .

Routers are different devices for transferring data between networks that allow electronic communication within a frequency range of (2.4 —5) GHz, providing high-speed data transfer. Routers control the flow of data in the internet network[8] .

the important question here is: Can humanity continue to neglect the balance between the requirements of development on one hand and the preservation of the environment on the other, by relying on unstudied ecological patterns that destroy humans, animals, plants, water, and the environment in all its dimensions?

This study aims to investigate the effect of the electromagnetic field emitted by mobile phones and home guidance devices on blood parameters to produce results and recommendations that ensure the safety and security of citizens from the danger of radiation, in a manner that suits our reality.

2-Effects of electromagnetic fields on biological systems

Biological effects occur when noticeable changes happen in the biological system after exposure to certain types of stimulants, such as radiation. The observation of biological effects in itself does not necessarily indicate the presence of biological risks or harmful health effects. The effects are only negative when the body cannot dissipate the high temperature resulting from the reaction Electromagnetic waves with the living system (tissues) in the natural activity of the body, such as blood flow and sweating[9] .

Despite the numerous studies on the effects of exposure to electromagnetic fields on biological systems, their results remain contradictory and uncertain, and knowledge in this research area is still incomplete. The mechanism of interaction between electromagnetic fields and tissues is still not precisely known. However, research reports have suggested several possibilities, including that exposure to electromagnetic fields leads to oxidative stress[10] through the formation of free oxygen radicals, which cause lipid peroxidation in the cell membrane and subsequently destroy it. Generally, the possible effects between magnetic fields and the biological system of the body occur through the rotation of particles in magnetic fields, the movement of particles in a non-uniform magnetic field, and the effect of the Lorentz force on the motion of charged particles in magnetic fields, such as ions and moving blood cells. The non-uniform magnetic field causes diamagnetic bodies to move in a direction that reduces the field strength, while paramagnetic and ferromagnetic materials move in a direction that increases the field[11] .

There are experimental results both inside and outside the body in previous years that have given significant importance to the biological effects of electromagnetic fields. These studies indicate links between exposure to electromagnetic fields and the condition of certain increasing tumors, particularly leukemia in children and adults, as well as the increased risk of brain tumors and neurodegeneration[12] . It is now known that the effect of low-frequency magnetic fields can alter cell activity and behavior through biological impact or physiological processes and the physical chemistry at the atomic levels that underlie interactions between biomolecules in the magnetic field, as the field can magnetically affect the chemical bonds between adjacent atoms responsible for producing free radicals. The effects resulting from electromagnetic fields can also be classified as thermal and non-thermal effects[13] , as exposure of the body or part of it to these fields may result in heat emission within the body due to the absorption of electromagnetic energy.

As a result, biological effects may later appear as clinical symptoms. The nature, severity, and timing of the clinical symptoms depend on the amount of radiation absorbed and the rate at which that radiation is received. Biological effects of radiation can be classified into physical effects and genetic effects on the offspring of the exposed individual. Additionally, exposure to radiation may lead to a shortened lifespan

[14] .

The interaction of very low-frequency electric and magnetic fields with the living body can occur through induction, which causes the generation of a weak electric current within the body (where the cell consists of two parts: the outer part, which is the insulating membrane, and the inner part, which is composed of cytoplasm and the nucleus). The fluid outside the cell is called extracellular fluid, which has high conductivity. Therefore, the induced or flowing currents are a combination of conduction current and displacement current, forming polarization of the charges present inside the cells or tissues due to the presence of water, which makes up more than 70%, and affecting the direction of polarization in its presence[15] .

3-Materials and Methods

The practical aspect includes two main parts.

1- Sample collection

In the experiment of our study which including, 24 laboratory rabbits, all males, were used. They were randomly selected at an age of (6—8) months and weighed between (1900—2400) gm, measured using a sensitive digital scale. These animals were placed in wooden cages, and the floors of the cages were furnished with sawdust. Also cleaned and disinfected with sanitizers, in addition to having clean drinking water bottles. The experimental animals were subjected to suitable laboratory conditions with a temperature of (22 —25) °C and a regular life cycle of 12 hours of light and 12 hours of darkness. They were provided with water and manufactured feed, as well as vegetables like carrots, cucumbers, and greens in the animal house belonging to the College of Education for Pure Sciences in Thi-Qar during the experimental period. Before starting the experiment, all animals were examined to ensure their health and absence of diseases. They were randomly divided into three groups, with the control group containing 8 animals, the second group containing 8 animals, and the third group containing 8 animals. The first group was the control group, while the second group was exposed to phone waves, and the third group was exposed to router waves . After completing the adaptation period in the laboratory, place the telephone or router with the animals on top of the wooden cage for three months, with an average exposure of 22 hours per day to radiation issued by these devices. The distance between (the phone and the router) was the same as the length of wooden box, and its dimensions (length 75 cm, height 30 cm, width 60 cm), where the (phone or router) was installed at top of box, that is, within height distance.

At the end of every 30 days over of 3 months of exposure to the waves from the Phone and Router, blood samples were taken either through cardiac puncture or ear puncture from each group. All samples were anesthetized with 1% Sodium pentobarbital (60mg/kg). 3ml was drawn using a medical syringe and placed in laboratory glass tubes containing an anticoagulant (EDTA). The tubes were then gently mixed until the

blood was homogeneous with the anticoagulant. The blood samples were divided into three groups: Phone exposure samples, Router exposure samples, and compared to blood samples that were not exposed to radiation (Control group).

2- Biochemical Study

- **Complete blood count and analysis apparatus**

These parameters were measured in a laboratory Iraq, in the Thi-Qar Governorate, using the Mindray BC 3000 Plus device, manufactured by the Chinese company Mindray. This device has the capability to measure up to 19 parameters and analyze 60 samples per hour (at a rate of one sample per minute). Several blood parameters were measured, including:

The total number of white blood cells (WBC), the total number of red blood cells (RBC), the percentage of lymphocytes (LYM%), the percentage of the combined value of types of white blood cells MID%, the percentage of neutrophils in the blood relative to the total number of white blood cells in the blood NEUT%, The level of hemoglobin (HGB) which is the protein found inside red blood cells that specializes in oxygen transport, This is after collecting blood samples and then calculating these parameters on the same day.

- **Statistical analysis**

The statistical program (SPSS) Statistical Package for Social Science was used to analyze the results obtained in this study statistically, and the analysis (Paired-Samples T-Test) was used to calculate the difference between the samples. All values are represented by the mean ± the standard line (SE). The significant results were considered at the level Probability $p<0.05$, and SPSS version .23 was used.

4 -Results and discussion

The results obtained in this work, illustrated in charts (1-12), showed the effect of the fields emitted from mobile phones and the routers on the following blood parameters: (WBC, LYM%, MID%, NEUT%, RBC, HGB).

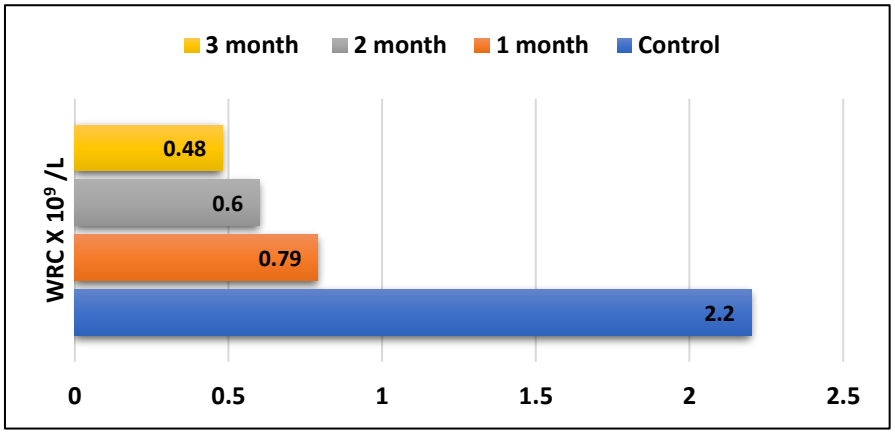

Figure (1)The number of White blood cells at exposure levels to Router waves

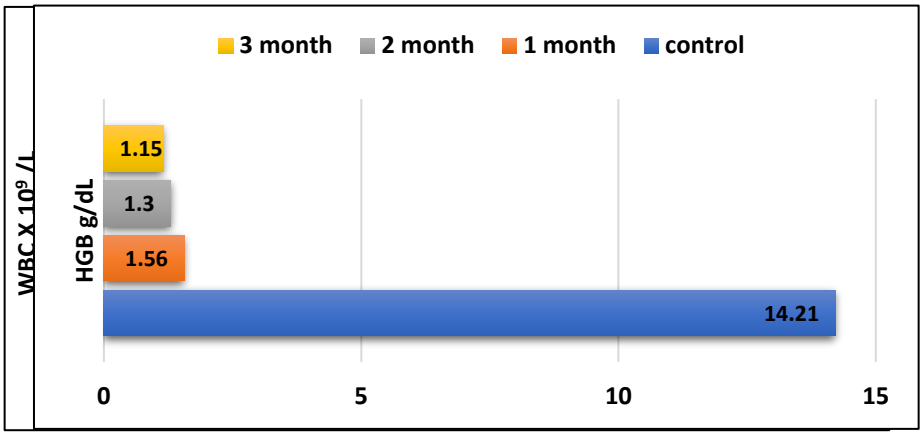

Figure (2) The number of White blood cells at exposure levels to Phone waves

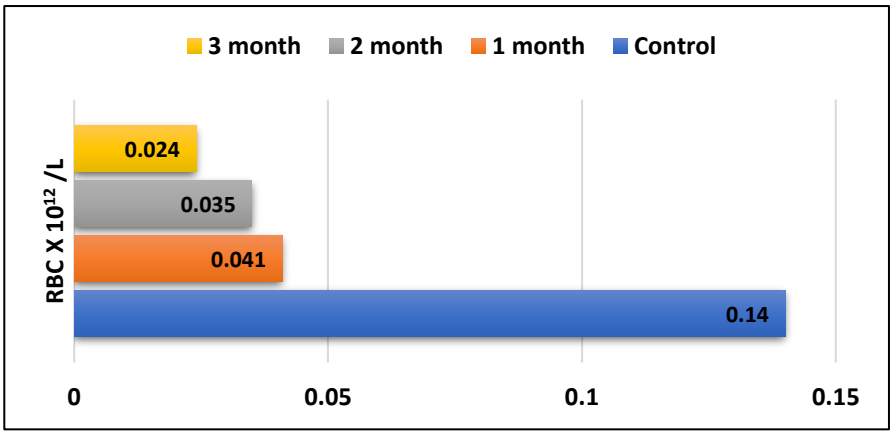

Figure (3) The number of Red blood cells at exposure levels to Router waves

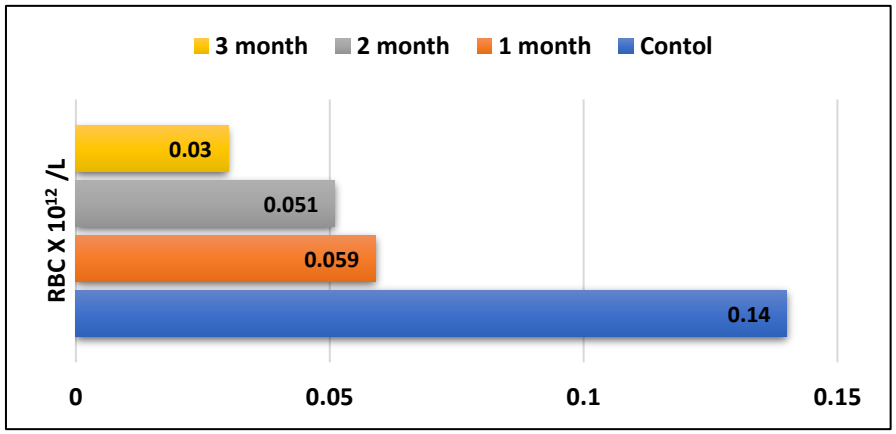

Figure (4) Number of unexposed and exposed Red blood cells to Phone wave

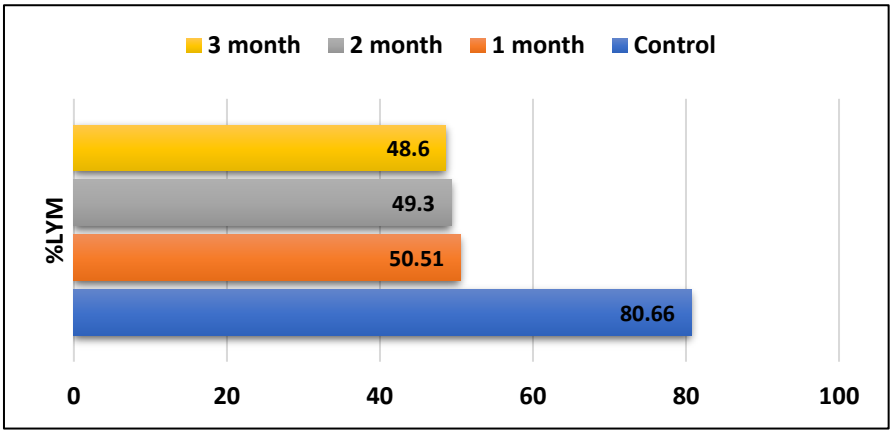

Figure (5) Concentration of blood dye for samples exposed to the Router wave

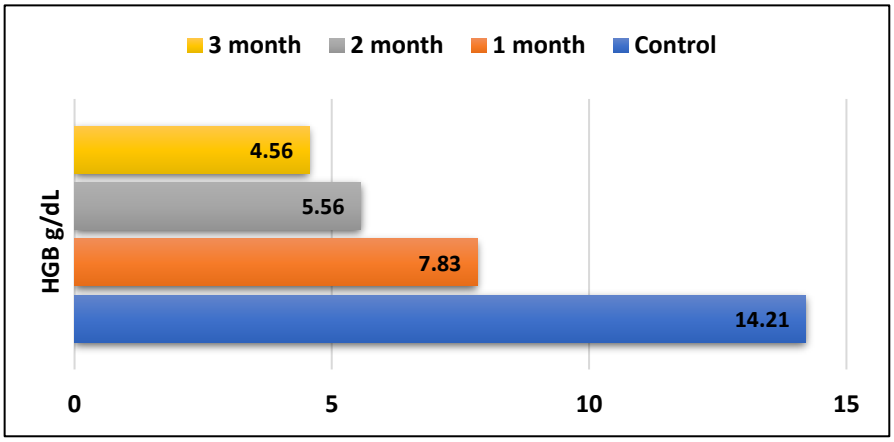

Figure (6)Concentration of blood dye for samples exposed to the Phone wave

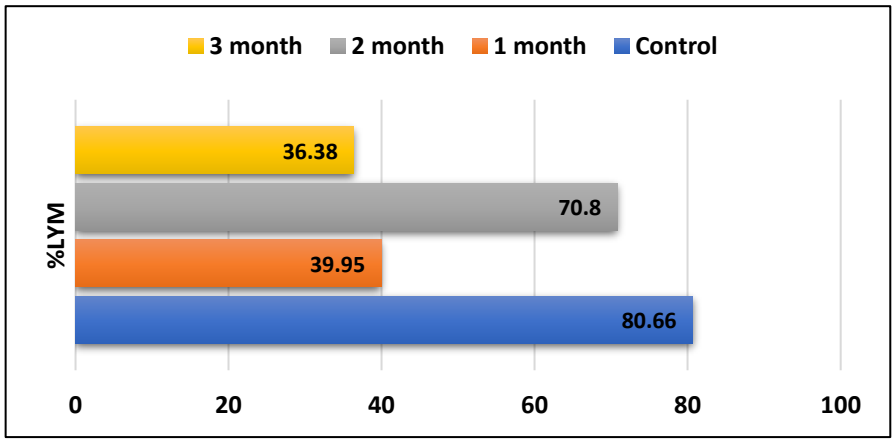

Figure (7) The percentage of lymphocytes in samples exposed to Router waves

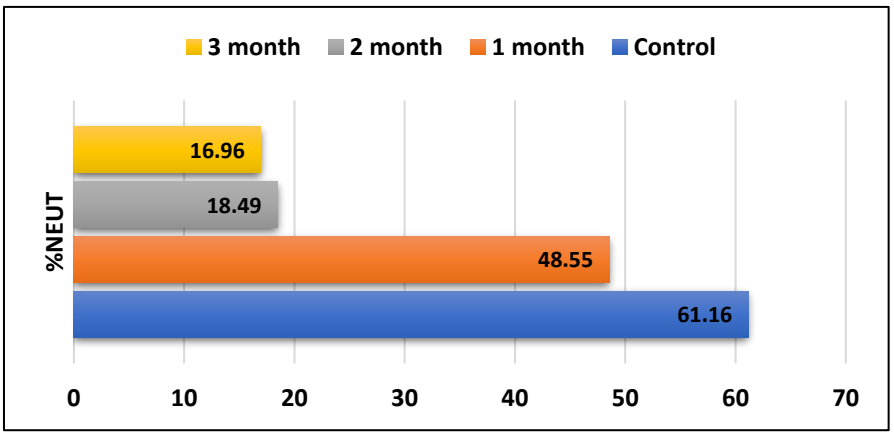

Figure (8) The percentage of lymphocytes in samples exposed to Phone waves

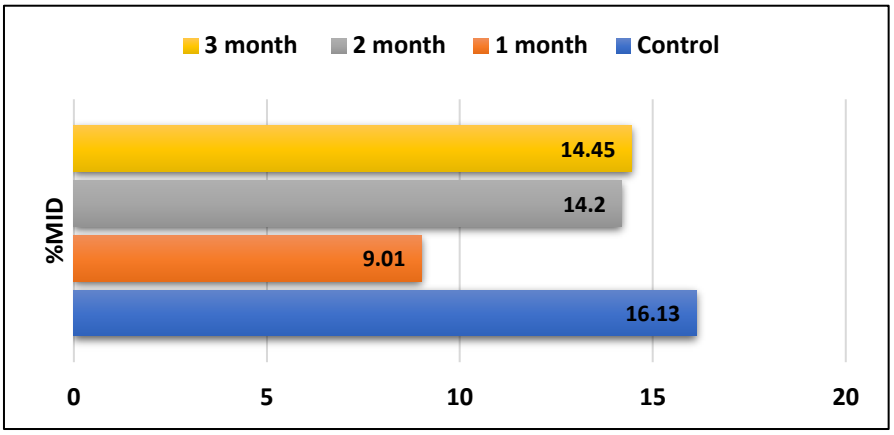

Figure (9) The aggregated value of white blood cell types for samples exposed to Router waves

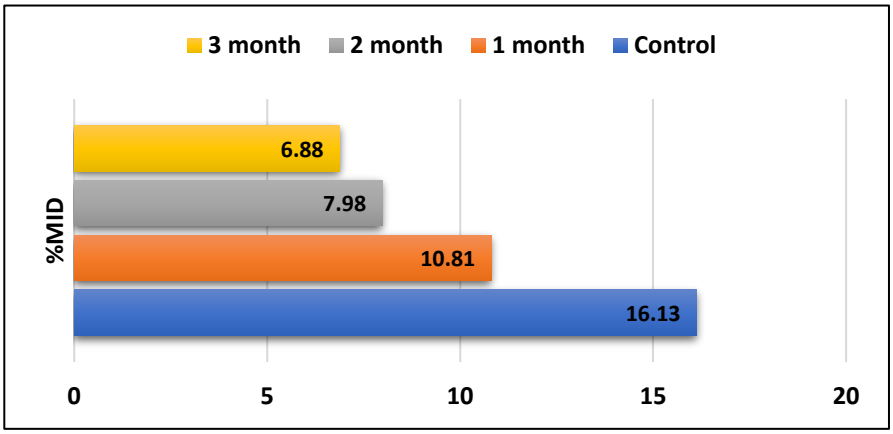

Figure (10) The aggregated value of white blood cell types for samples exposed to Phone waves

Figure (11) The level of neutrophils in the blood of exposed samples to Router wave

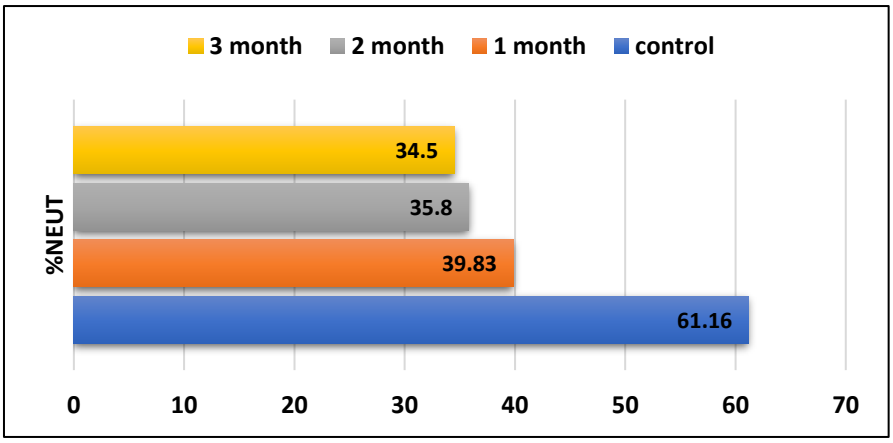

Figure (12) The level of neutrophils in the blood of exposed samples to Phone wave

The results shown in the graphical figures (1-12) indicate a significant difference in the impact of the magnetic fields emitted from mobile phones and routers on the following blood parameters: (WBC), (RBC), (HGB), (LYM%), (MID%), (NEUT%) at a significance level $p<0.05$ using SPSS.

There is a clear decrease in the number of WBC in blood samples taken from animals exposed to phone waves and the router device (which was considered the treatment model) compared to samples taken from animals not exposed to the waves (which was considered the control model). This decrease may be due to diseases in the bone marrow, where some cases lead to the destruction or inhibition of white blood cell production in the bone marrow, in addition to aplastic anemia. This is consistent with what was found by [16], one can easily observed a 46\7 decrease in WBC in blood samples taken from factory workers aged between 25 and 35 years, who were exposed to electromagnetic waves for 48 hours weekly.

The decrease in the number of WBC, especially (MID%), in this study may be attributed to their inhibition due to the fields emitted from mobile phones and routers, despite the fact that the intensity emitted from them is moderate according to specialists in this field. This is because they are quickly affected as they are the body's first line of defense and may be more affected by increases or decreases if exposed to a stronger

magnetic field intensity. Additionally, the concentration of (HGB) is affected by the emitted fields, possibly due to their impact on the liquid contents of RBC. There are also significant differences in some blood parameters such as red blood cells (RBC), the percentage of immune lymphocytes (LYM%), which aligns with the findings of the researcher[17] , easily to note a significant decrease in RBC and HGB in rats exposed to mobile phone waves for 4 hours daily over a 6-week exposure.

Moreover [18] , showed a decrease in RBC levels in a group of male white mice exposed to 900MHz mobile phone waves. The study[19] conducted on 30 mice exposed to 2.4GHz Wi—Fi waves at a distance of one meter for 8 hours daily over a 6-month exposure showed that RBC and HGB were in the lower range of normal values compared to the control group.

This differs from what the researcher [20] found, as he observed a significant increase in red blood cells (RBC) and hemoglobin concentration (HGB) when exposing laboratory rats to medium-intensity electromagnetic fields. Similarly, [21] reported an increase in total white blood cells, with the percentage of lymphocytes, neutrophils and monocytes as well as a significant increase in RBC, HGB and platelet count in mice (Swiss albino) exposed to EMF (50 KHz) for 6 weeks for 4 hours daily).This difference may be due to variations in intensity or in the exposure process or the distance separating the animal from the exposure source (the animal or blood) to the magnetic field.

5 -Conclusion

1The electromagnetic fields emitted by the mobile phone and the router caused numerical changes in blood parameters.

2- Long exposure to electromagnetic waves affects the functions of the immune system.

3- Effects of electromagnetic waves on the number of WBC and RBC, which can either increase or decrease according to search results.

6 - Recommendations

1- Try to reduce the time you spend using your mobile phone and sitting near the router.

2- Using wired communications (such as cable internet) is better than wireless networks when possible.

3- Turn off the router at night or when you don't need it.

4- Educate yourself and your family about the various options for electromagnetic waves and how you can cope with them.

Acknowledgment and Appreciation: The researcher thanks the Deanship of the College of Education for Pure Sciences / University of Thi-Qar for their constructive cooperation and all the specialized professors.

REFERENCES

[1] K. Rekecho, “Electricity and Environmental Pollution, the Effect of Electromagnetic Fields on Health,” AL-Zad Company, Jeddah, 1999.

[2] Aziz , A. A. , (2002), " Measurement of the Concentration of Radioactive Materials in Water and Sediments from Tigris River by Gamma Ray Spectroscopy" ,M.SC. Thesis submitted college of Science of Bagdad Univ. Iraq.

[3] Odac\i E, \.Ikinci A, Y\ild\ir\im M, Kaya H, Akça M, Hanc\i H, et al. The effects of 900 megahertz electromagnetic field applied in the prenatal period on spinal cord morphology and motor behavior in female rat pups. NeuroQuantology. 2013;11(4):573–81.

[4] Lak , A. , (2012) , " Human Health Effects from Radiofrequency and Microwa-ve Fields " , Journal of Basic and Applied Scientific Research , Vol. 2. Nol. 12 , PP. 12302 – 12305.

[5] "Specific Absorption Rate (SAR) For Cell Phones: What It Means For You". Federal Communications Commission. 19 May 2011. Retrieved 22 December 2013.

[6] Urbinello D, Joseph W, Verloock L, Martens L, Röösli M. Temporal trends of radio-frequency electromagnetic field (RF-EMF) exposure in everyday environments across European cities . Environ Res 2014 ;134 : 134 – 42 doi : 10 . 1016 / envres 2014 . 07 . 003.

[7] Mann, S. ,“Assessing personal exposures to environmental radio frequency electromagnetic fields”, C R Phys, Vol. 11, pp. 541–555,2010.

[8] "What Is Routing?"Cisco. 2022-04-10. Retrieved 2024-03-25. Routing tables can be created manually and "learned" by software as it observes network traffic, or they can be built according to routing protocols.

[9] Anthony Bassesuka Sandoka Nzao"Study and Modeling of Human Biological Tissue Exposed to High Frequency Electromagnetic Waves"Open Journal of Applied SciencesVol.11 No.10, October 2021.

[10] Kıymet Kübra Yurt, Arife Ahsen Kaplan, Işınsu Alkan, "Effects of electromagnetic fields exposure on the antioxidant defense system" , 2017 Oct-Dec; 5(4): 167–176. Published online 2017 Aug 2. doi: 10.1016/j.jmau, 2017.07.003PMCID: PMC6025786PMID: 30023251

[11] SCENIHR. Potential health effects of exposure to electromagnetic fields. Scientific committee on emerging and newly identified health risks; 2015.

[12] Fernando Pareja-Peña et al "Evidences of the radiofrequency electromagnetic field influence on brain tumor induction" Int J Environ Health Res. 2022 Jan.

[13] Gartshore, A.; Kidd, M.; Joshi, L.T. Applications of microwave energy in medicine. Biosensors 2021.

[14] Khalid Al-Badri, "Biological effects of electromagnetic waves " January 2017 DOI:10.13140/RG.2.2.16910.31041.

[15] Gandhi, O. M. P., (1990), Editor” Biological Effects and Medical Applications of Electromagnetic

Energy," prentice Hall, NJ

[16] Arash Abdolmaleki,' FSanginabadi, A Rajabi,The Effect of Electromagnetic Waves Exposure on Blood Parameters, Journal of hematology Oncology and Stem Cell Research, Vol. 6, No. 2 ; Apr, 2012

[17] Marwa Ali Abd Al Abas, Zaid Makki Mohammed AL-Hakkak, "Effect Exposure of Mobile Phone Radiation on Blood Parameters in Rats" Archives / Vol 62 No 11 (Special Issue) (2021): 2nd International Conference of Alkarkh University of Science.

[18] Mona H. Ibraheim, Magda S. Hanafy, Samir A. Nassar, Amir shahwan, "Effects of radiofrequency radiation emitted from mobile phone on hematological parameters in albino mice" Arab Journal of Nuclear Sciences and Applications, 10.21608/ajnsa.2020.25830.1338.

[19] Nurul Arafah Ishak, Azuwa Ali, R. Ariffin , "Biological effects of WiFi electromagnetic radiation", DOI:10.1109/ICCSCE.2011.6190587Conference:Control System, Computing and Engineering (ICCSCE), 2011 IEEE International Conference on

[20] Ahmed R. Mathloom,AbdulbariA.Alfaris & ZekiA.Ahmed, Calculation of the Specific Absorption Rate (SAR) and Absorption Ratio of the Thyroid Gland in Rabbits at the Frequencies (9, 10.5, 12) GHZ" , 1st International Conference on Advanced Research in Pure and Applied Science", which will be held at College of Science / Al- Muthanna University, Iraq during 24-25 March, 2021. Your paper will be published online by AIP Conference Proceedings (ISSN: 0094-243X).

[21] M.A. Hashem, and N.L. El-Sharkawy, "Haemato-Biochemical and Immunotoxicology Effects of Low Electromagnetic Field and Its Interaction With Lead Acetate in Mice", Iraqi Journal of Veterinary Sciences, vol. 23, no. 3, 2009.