Vol-11, Issue-2 PP. 13-21 ISSN: 2394-5788

GLOBAL JOURNAL OF ADVANCED RESEARCH
(Scholarly Peer Review Publishing System)

EFFECT OF RADIO FREQUENCY RADIATION EMITTED FROM BASE TRANSCEIVER STATION (CELL TOWER): A HISTOPATHOLOGICAL AND OCULAR STUDY ON ALBINO MICE

Ogunjobi Esther Ifeoluwa
Pure and Applied Physics
Department. Ladoke Akintola
University of Technology,
Ogbomoso,
Nigeria.
ogunjobiesther54@gmail.com

Amuda Dauda Biodun*
Pure and Applied Physics
Department. Ladoke Akintola
University of Technology,
Ogbomoso,
Nigeria.
dbamuda@lautech.edu.ng

Oni Olatunde Micheal
Pure and Applied Physics
Department. Ladoke Akintola
University of Technology,
Ogbomoso,
Nigeria.
omoni@lautech.edu.ng

Olawoore Ibidotun Theophilus
Department of Chemistry,
Ahmadu Bello University Zaria,
Nigeria.

Rabba James Anthony
Department of Physics,
Federal University of Lokoja,
Nigeria.

***Corresponding Author**: Amuda Dauda Biodun

ABSTRACT

The electromagnetic radiation from base stations (cell towers) is a subject of recent study because of the enormous increase of mobile phones masked and mobile phone use through-out the world. The aim of this study was to investigate the effect of radio frequency radiation emitted from base station transceiver station (cell tower) on histopathological changes in the brain and eyes of albino mice. In this study, 45 albino mice with a weight range of 15-20 g were randomly assigned to three groups: Group A (control) consisted of 15 mice with no radiation exposure, Group B had 15 mice exposed to radiation from the hours of 10a.m to 6a.m, and Group C had 15 mice exposed to radiation from the hours 10p.m to 6a.m from 1500MHz radiofrequency radiation from the base transceiver station. The magnetic field intensity (H) in A/m, the power density (S) and the electric field (E) emitted from from base station transceiver station were measured using a hand-held electro-smog meter. The control group was kept in a zero-electromagnetic field environment, with no exposure to electromagnetic fields for the same length of time as the control group. After 90 days all the mice were sacrificed at the end of the experiment. The organs of the animals harvested for histopathological examination. The results of the study revealed a significant decline in antioxidant activity, a substantial increase in lipid peroxidation, and notable damage to eye and brain tissues in the exposed groups (B and C), compared to the control group (A). Notably, no significant differences were observed in the extent of damage between the groups exposed during working hours (B) and sleeping hours (C), suggesting that radiation exposure during both periods had similar harmful effects. It is concluded that radio frequency radiation exposure can cause a longtime damage to the cells

and tissues in the body, it is important to increase public consciousness of potential adverse effects of base station transceiver radiofrequency electromagnetic radiation exposure.

General Terms

Radiofrequency; radiation; base transceiver station; histopathological; electromagnetic field environment; mobile technology

Keywords

Radiofrequency; radiation; base transceiver station; histopathological

1. INTRODUCTION

Our contemporary generation is heavily reliant on technology, with radiofrequency radiation (RFR) exposure being widespread, especially in public places where wireless devices such as mobile phones are routinely used for personal or industrial reasons (Miller et al., 2019; Owolabi et al., 2021). This extensive use of mobile technology worldwide has raised concerns about its potential health hazards. Researchers globally are increasingly interested in the effects of mobile phone radiation on human health, particularly with the consistent use of mobile communication devices leading to a rise in ear-related symptoms (Mani, 2019; Jayaraju et al., 2023). In Nigeria today, the total number of mobile network subscribers has increased to 148,745,464, according to the Nigeria Communication Commission (NCC) (Aremu et al., 2019). The rapid and widespread use of this technology has significantly contributed to economic growth (Solomon & Van Klyton, 2020). A significant deployment of base stations has resulted from the rise in mobile phone usage (El-Saleh et al., 2023). Based on various factors, including the number of network providers, users, simultaneous calls, and base stations, a nation's base station count may increase (Balmori, 2022).
These stations are often located close to residences or other buildings, raising concerns about human exposure. The level of exposure to radiofrequency electromagnetic fields (EMFs) caused by these base stations is a pressing issue (Chiaramello et al., 2019; Moon, 2020). Local and national authorities, network providers, and private citizens should consult reputable organizations to investigate non-ionizing electromagnetic field exposure levels in prohibited regions (Ramirez-Vazquez et al., 2024). Public concern is particularly high in countries like France, Romania, Italy, Australia, New Zealand, Portugal, and Nigeria. The cellular communication system is a recognized method for providing connectivity solutions for point-to-point and point-to-multipoint applications. Examples of wireless communications include AM and FM radio, television transmission, mobile phones, radar, and microwave systems (Ugweje, 2004). The electromagnetic (EM) frequency spectrum consists of two main subgroups: ionizing and non-ionizing radiation. The frequencies utilized by cellular base stations 900, 1800, 1900, and 2100 MHz are classified as non-ionizing radiation (Samaila et al., 2023). While ionizing radiation has a stronger impact on human organs, the non-ionizing radiation emitted by cellular base stations does not change the atomic structure of living things but still affects human cells in ways that are not fully understood and could be harmful to human health (Tuieng et al., 2021; Omer, 2021).

In Nigeria, thousands of mobile base stations have been set up to support the growth of mobile telephony (Monyei et al., 2018). There is considerable public concern about the electromagnetic fields created by these base stations, especially among those living close to GSM masts who worry about potential health impacts. Studies suggest that people living near telecommunication poles are more likely to develop cancer, lung disease, sleep disturbances, memory loss, poor sperm count, and even physical disabilities (Balmori, 2022). According to the World Health Organization (WHO), there is currently no scientific proof of health risks associated with telecommunication masts. However, living in an environment populated by students and young people necessitates studying the level of radiofrequency radiation emitted by telecommunication masts to determine whether it is significant enough to impact humans, as some researchers claim, and to make any necessary recommendations (Miller et al., 2019; Ijabor et al., 2023).

Although exposure from base station antennas is far less than that from handheld devices, the public appears to be more concerned about the safety of base stations (De Giudici et al., 2021). For this reason, the WHO has recommended further research on this subject. In some parts of Nigeria, there is little to no information about electromagnetic radiation from base station antennas and their effects on human health (Aminu et al., 2021). This research aims to investigate the effect of radio frequency radiation emitted from base station transceiver station (cell tower) on histopathological changes in the brain and eyes of albino mice.

2. MATERIALS AND METHOD

2.1 Statement of the experiment

The research work was conducted in the Department of Pure and Applied Physics, Faculty of Pure and Applied Science, Ladoke Akintola University of Technology, Ogbomosho during the period from August 2023 to December 2023 to assess the effect of radio frequency radiation emitted from base s transceiver station (cell tower) on histopathological changes in the brain and eyes of albino mice.

2.2 Animals and experimental procedures

Albino mice (6 weeks old) (15-20 g) have been obtained from the International Center for Diarrheal Disease Research (ICDDRB), Ogbomosho, Oyo state. All the mice appeared to have good health and lacked any visible deformities. In the temperature-controlled environment, the mice were kept 52 cm by 36 cm by 25 cm in wooden cages. Daily diet and drink water were given. After one week of acclimatization, the mice were haphazardly categorized into three equivalent groups; each group includes fifteen mice. The group named were A, B, and C. Individual weights of all mice were documented before radiation exposure. Among all of the three groups, group A has been considered controlled without radiation exposure. Group B was exposed to radiation from hours of 10a.m to 6a.m, and Group C had 15 mice exposed to radiation from the hours 10p.m to 6a.m from base stations (cell towers). Both experimental and operational requirements were designed to comply with the Care and Use of Laboratory Animals published by the U.S. National Institutes of Health.

2.3 The electromagnetic radiation location and exposure system

Three different locations were chosen for the experiment. The control group (A) location was chosen at Ayegun Baptist church college with longitude 4.214° E and latitude 7.990°N, an area that is free from radiofrequency. The exposed group (B) which is the exposure1 was located at jubilee junction, Temidire Atoyebi estate with longitude 4.130°E and latitude 8.459°N and the exposed group (C) location at Ogbomosho Baptist high school with longitude 4.231°E and latitude 8.108°N. The magnetic field intensity (H) in A/m, the power density (S) and the electric field(E) were measured using a hand-held electro-smog meter. This meter can measure frequency that ranges from 50 MHz to 3.5 GHz. The measurement could be taken from any angle because most of the GSM mast are equipped with at least three sectorial antennas.

Measurement was taken at a distance of 20m to 100m radius from each base masts.it was taken by holding the meter in an arm lenght,1.5m above the sea level, and pointed towards the mast. The value of the measure parameters was taken and recorded. All the animals were observed daily for clinical signs and mortality throughout the 3 months of experiment once before dozing and once after dosing to up to 4 hours after dosing. The mouse behavior was observed and recorded. Safety measures were also put in place to monitor the environmental conditions that guarantee animal welfare. The body weight of the animals was taken and recorded during the acclimatization period, before the commencement of the dosing, once on weekly bases during the exposure and once on the day of sacrifice using a sensitive electronic balance.

2.4 Laboratory Analysis

At the end of 3 months (90 days) the animals were sacrificed. The universal bottles were used to collect the various organs and preserved using 10% formalin to determine the histopathological parameters.

2.5 Histopathology of the eyes and brain

Dissected mice brain and eyes were fixed in 10% buffered formalin solution followed by the dehydration, cleating, embedding in paraffin blocks and cut into fine sections using a microtone. These sections were mounted on glass slides and stained with hematoxylin and eosin. The stained sections were examined by oil immersion light microscopy and several digital images were taken using Kodak digital camera

2.6 Statistical Analysis

T test was used to check for significant differences between two variables. T-test is an inferential statistic used to determine if there is a significant difference between the means of two groups and how they are related.

3. RESULTS AND DISCUSSION

Table 1 shows the distance measured on the two different base transceiver station for the control groups A and B. It was noticed that at a distance of 20m, the Radiofrequency level of the two BTS are almost the same with little or no difference between the two BTS. The RF at this level is very high compared to other meters. At this distance, the measuring meter is relatively close to the BTS. The signal strength is likely to be strong, resulting in excellent reception and high data transfer speeds. Human beings within the range of this meter can expect minimal interference and stable connectivity whereby be at a higher risk of been exposed to Radiofrequency.

This is known as the peak of the exposure. The RF at 40 m is lower than that of 20 m which shows that the environment is also at risk at this distance. The device is still quite close to the BTS at this distance. Signal strength remains robust, providing reliable reception and fast data transfer rates. Users should experience little to no degradation in signal quality so also the Radiofrequency level is high. There is a little similarity between the RF of these two meters the RF reduced more compared to when it is at 40 meters, the more you move away from the BST, the RF reduced and the lower the risk. The RF level at 60 m reads 0.150 for the first BST, and it reads 0.146 for the second BTS.

It shows that there is a significant relation between the RF of the two masts. Distance really shows a positive change in the RF level, that means it is always affected by distance. The RF level at 80m has reduced unlike the one closer to the mast. The individual at this distance is exposed but at a frequency lower than the distance of 60m. The closer you are to the BTS the higher the Radiofrequency and the more an individual is exposed'. Which is in accordance with Amuda et al., (2021) which shows that the base station average power density decreases as the radial distance (away from the BTS) increases and also there is a variation in radiation intensity from one base station to the other.

Table 1: Distance measured on the 2 Base Transceiver Station

S/N	Distance (m)	MTN (EX 1) u W/CM	MTN (EX 2) u W/CM
1	20	0.455	0.421
2	40	0.295	0.264
3	60	0.230	0.285
4	80	0.229	0.218
5	100	0.150	0.146

3.1 Histopathological Effect of Radiofrequency on the Brain

The sections of the exposure 1, the mice that were exposed during the hour of 8am to 4pm reveal that there is an occasional neurons dense nuclear material and eusinophilic cytoplasm as it was shown in plate 4.6. The sections of the exposure 2, the mice exposed during the hour of 10am to 6am shows occasional neurons dense nuclear materials and eusinophilic cytoplasm as show in plate 4.7. The control group shows a normal pyramidal neutron with large nuclei prominent nuclei and basophilic cytoplasm glial cells that have round to oval nuclei which was not present in the both exposed groups.

3.2 Ocular Effect of Radiofrequency on the Eye

The cornea plays a crucial role in vision as it serves as the eye's outermost lens, responsible for refracting light onto the retina. Its cellular composition contributes to its transparency and refractive properties: A cornea exhibiting a focal area of epithelial hyperplasia and loss of rod and cone cells in the outer nuclear layer suggests significant pathological changes that can impact vision. Here's a discussion of these findings: Epithelial Hyperplasia: The presence of epithelial hyperplasia, characterized by an abnormal increase in the number of epithelial cells, indicates an active response to injury or irritation. This could result from various factors such as chronic inflammation, trauma, or underlying diseases affecting the cornea.

Epithelial hyperplasia can disrupt the corneal surface regularity, leading to visual disturbances such as irregular astigmatism or decreased visual acuity. Loss of Rod and Cone Cells: The loss of rod and cone cells in the outer nuclear layer is concerning as these photoreceptor cells are essential for vision. Rod cells are responsible for peripheral and low-light vision, while cone cells mediate central and color vision. The presence of such loss suggests damage to the neural tissue of the retina, which may result from conditions like retinal degeneration, ischemia, or inflammatory processes affecting the eye.

Impact on Vision: The combined effects of epithelial hyperplasia and loss of rod and cone cells can severely impair vision. Epithelial irregularities can cause distortions in vision quality, while the loss of photoreceptor cells compromises both peripheral and central vision, as well as color perception. Patients with these corneal and retinal changes may experience symptoms such as blurred vision, decreased contrast sensitivity, and difficulty seeing in dim light conditions. Clinical Implications: Understanding these histopathological findings is crucial for clinical management and prognosis. Further investigation into the underlying cause of epithelial hyperplasia and photoreceptor loss is warranted to guide treatment strategies.

This may involve addressing underlying systemic conditions, managing ocular inflammation, or exploring options for corneal and retinal repair or transplantation. The cornea Shows the focal area of epithelial hyperplasia and also a loss of rod and cornea cells in the outer nuclei layer in group B (Fig. 2). The group C shows cornea with focal area of epithelial hyperplasia and also a loss of rod and cornea cells in the outer nuclear layers (Fig. 3). The group A (Control) section shows cornea lined by non-keratinizing stratified squamous epithelium. The retina reveals outer nuclei layers composed of rod and cornea cells. (Fig. 1).

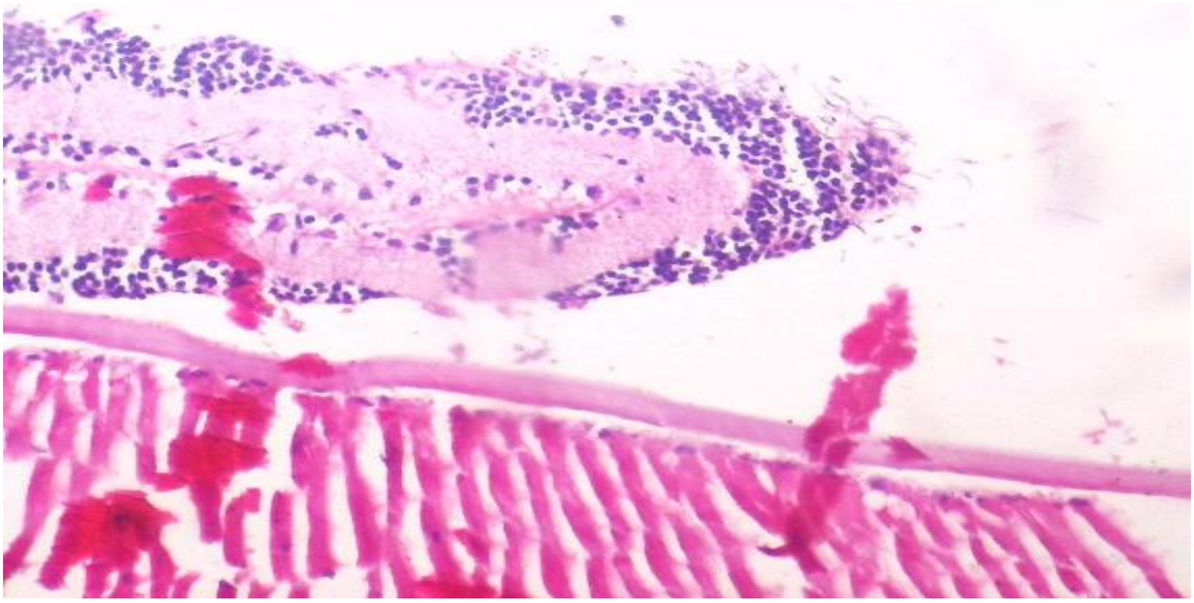

Figure 1: Photomicrograph of the control eye

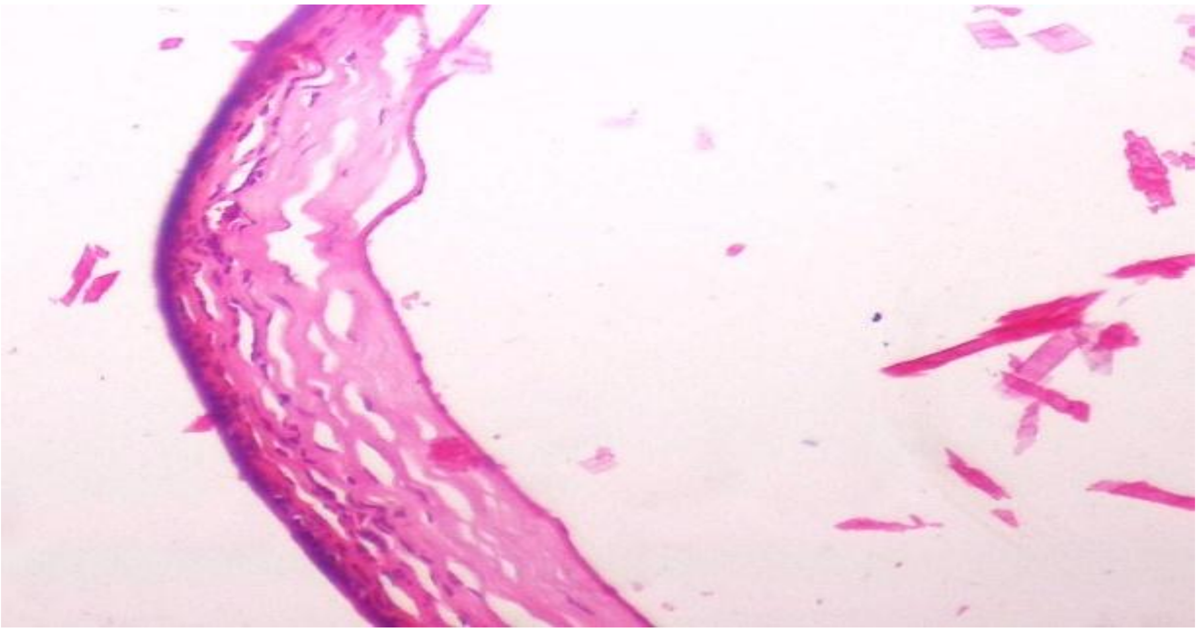

Figure 2: Photomicrograph of the eye of exposed group B

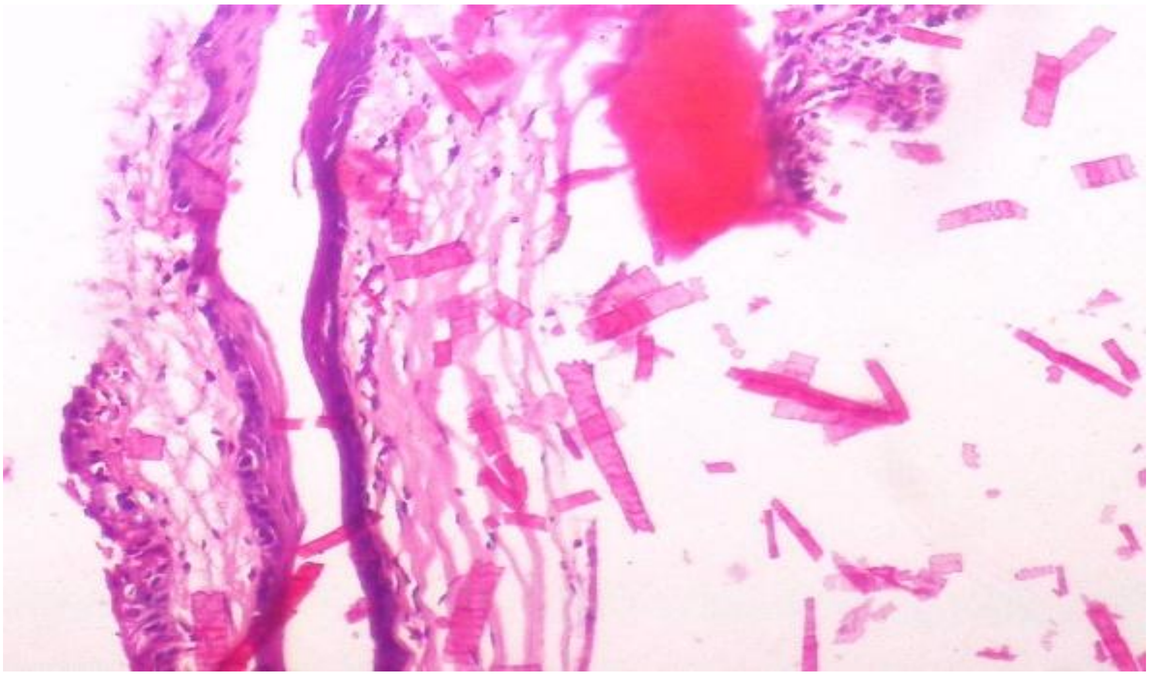

Figure 3: Photomicrograph of the eye of exposed group C

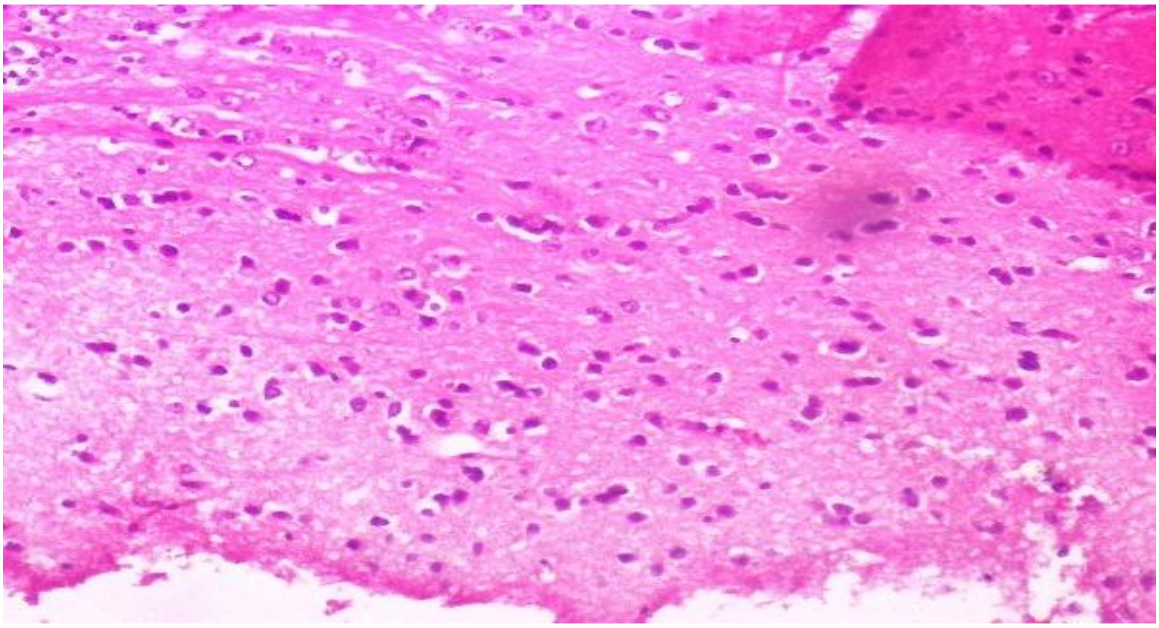

Figure 4: Photomicrograph of the brain group A (Control)

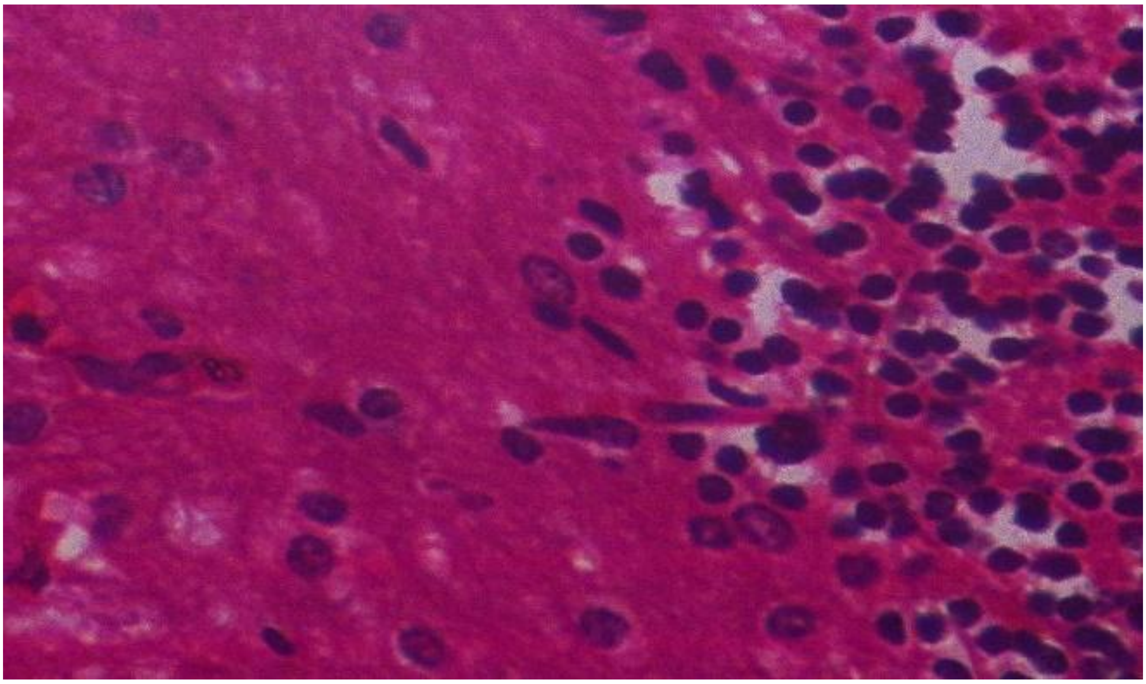

Figure 5: Photomicrograph of the brain exposed ground B

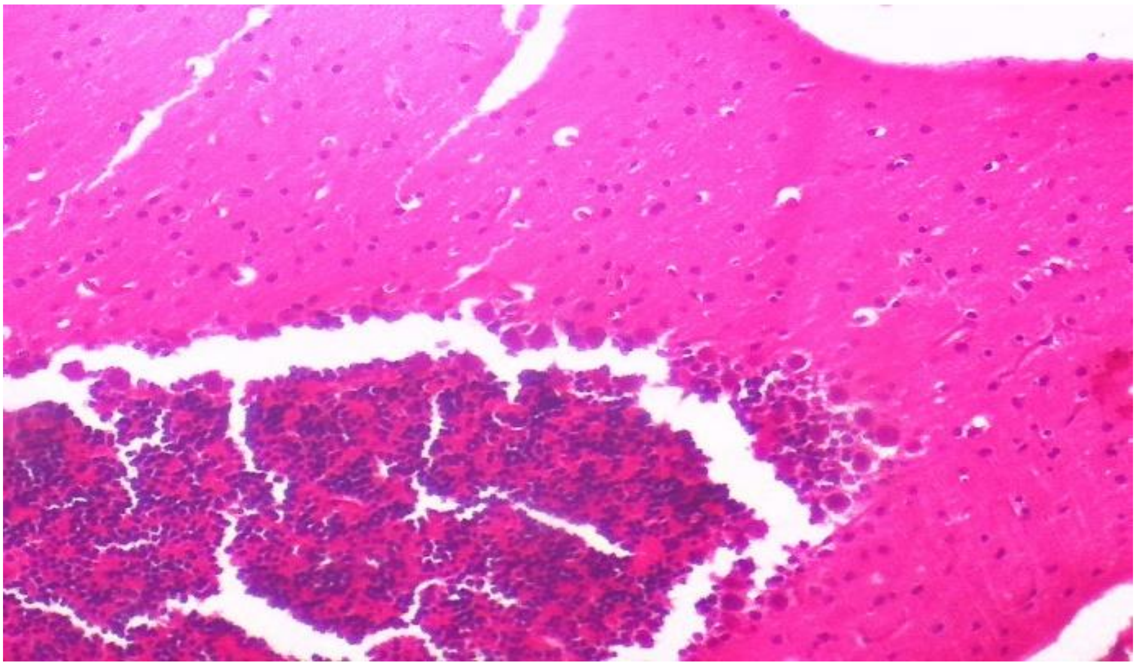

Figure 6: Photomicrograph of the brain exposed ground C

4. CONCLUSION

In conclusion, radiofrequency waves emitted by base transceiver stations have adverse effects on the brains and eyes of albino mice, leading to various histopathological alterations that can result in brain necrosis. Although numerous studies have reported brain histopathological alterations following radiofrequency exposure, the underlying mechanisms are not yet fully understood. Future molecular and cellular experiments will be essential to elucidate the exact mechanisms behind the adverse effects of radiofrequency on the nervous system.

REFERENCES

[1] Aminu, I., Zhimwang, J. T., Adewumi, D., Ibrahim, R. S., Musa, M. Z., & Matthew, D. D. (2021). Measurement and Evaluation of Radiation Power Density Emitted from Mobile Cellular Base Stations in Abuja and its Environ, Nigeria. Asian Journal of Research and Reviews in Physics, 7–13. https://doi.org/10.9734/ajr2p/2021/v4i130132

[2] Aremu, A. O., Makinde, S, O., Oyinkanola, L. O. A., & Akande, A. (2019). Analytical Study of Radio Frequency Radiation Exposure Level from Different Mobile Base Transceiver Stations in Urban area. International Journal of Scientific Research in Computer Science, Engineering and Information Technology, 457–461. https://doi.org/10.32628/cseit195282

[3] Balmori, A. (2022). Evidence for a health risk by RF on humans living around mobile phone base stations: From radiofrequency sickness to cancer. Environmental Research, 214, 113851. https://doi.org/10.1016/j.envres.2022.113851

[4] Balmori, A. (2022b). Evidence for a health risk by RF on humans living around mobile phone base stations: From radiofrequency sickness to cancer. Environmental Research, 214, 113851. https://doi.org/10.1016/j.envres.2022.113851

[5] Chiaramello, E., Bonato, M., Fiocchi, S., Tognola, G., Parazzini, M., Ravazzani, P., & Wiart, J. (2019). Radio Frequency Electromagnetic Fields Exposure Assessment in Indoor Environments: A review. International Journal of Environmental Research and Public Health/International Journal of Environmental Research and Public Health, 16(6), 955. https://doi.org/10.3390/ijerph16060955

[6] De Giudici, P., Genier, J., Martin, S., Doré, J., Ducimetière, P., Evrard, A., Letertre, T., & Ségala, C. (2021). Radiofrequency exposure of people living near mobile-phone base stations in France. Environmental Research, 194, 110500. https://doi.org/10.1016/j.envres.2020.110500

[7] El-Saleh, A. A., Alhammadi, A., Shayea, I., Hassan, W. H., Honnurvali, M. S., & Daradkeh, Y. I. (2023). Measurement analysis and performance evaluation of mobile broadband cellular networks in a populated city. Alexandria Engineering Journal /Alexandria Engineering Journal, 66, 927–946. https://doi.org/10.1016/j.aej.2022.10.052

[8] Ijabor, B. O., Nwabuoku, A. O., Izediunor, V. C., Odene, C. C., Agbonaye, I., Ebite, E. C., & Elumeshike, C. S. (2023). Assessment of Radiation Risk from Selected Telecommunication Base Station in Ogwashi-Uku, Delta State, Nigeria. OAlib, 10(03), 1–12. https://doi.org/10.4236/oalib.1109833

[9] Jayaraju, N., Kumar, M. P., Sreenivasulu, G., Prasad, T. L., Lakshmanna, B., Nagalaksmi, K., & Madakka, M. (2023). Mobile phone and base stations radiation and its effects on human health and environment: A review. *Sustainable Technology and Entrepreneurship*, *2*(2), 100031. https://doi.org/10.1016/j.stae.2022.100031

[10] Mani, R. (2019). Do Mobile Phones Cause More Harm than Good? *Open Journal of Social Sciences*, *07*(08), 198–205. https://doi.org/10.4236/jss.2019.78014

[11] Meo, S. A., Almahmoud, M., Alsultan, Q., Alotaibi, N., Alnajashi, I., & Hajjar, W. M. (2018). Mobile phone base station tower settings adjacent to school buildings: Impact on students' cognitive health. *American Journal of Men's Health*, *13*(1), 155798831881691. https://doi.org/10.1177/1557988318816914

[12] Miller, A. B., Sears, M. E., Morgan, L. L., Davis, D. L., Hardell, L., Oremus, M., & Soskolne, C. L. (2019b). Risks to Health and Well-Being from Radio-Frequency radiation emitted by cell phones and other wireless devices. *Frontiers in Public Health*, *7*. https://doi.org/10.3389/fpubh.2019.00223

[13] Miller, A. B., Sears, M. E., Morgan, L. L., Davis, D. L., Hardell, L., Oremus, M., & Soskolne, C. L. (2019c). Risks to Health and Well-Being from Radio-Frequency radiation emitted by cell phones and other wireless devices. *Frontiers in Public Health*, *7*. https://doi.org/10.3389/fpubh.2019.00223

[14] Monyei, C. G., Adewumi, A. O., Obolo, M. O., & Sajou, B. (2018). Nigeria's energy poverty: Insights and implications for smart policies and framework towards a smart Nigeria electricity network. *Renewable & Sustainable Energy Reviews*, *81*, 1582–1601. https://doi.org/10.1016/j.rser.2017.05.237

[15] Moon, J. H. (2020). Health effects of electromagnetic fields on children. *Clinical and Experimental Pediatrics*, *63*(11), 422–428. https://doi.org/10.3345/cep.2019.01494

[16] Omer, H. (2021). Radiobiological effects and medical applications of non-ionizing radiation. *�Al-�Mi'galaẗ Al-sa'udiyaẗ Lī-ulum Al-ḥayaẗ*, *28*(10), 5585–5592. https://doi.org/10.1016/j.sjbs.2021.05.071

[17] Owolabi, J., Ilesanmi, O. S., & Luximon-Ramma, A. (2021). Perceptions and experiences about Device-Emitted Radiofrequency radiation and its effects on selected brain health parameters in southwest Nigeria. *Curēus*. https://doi.org/10.7759/cureus.18211

[18] Ramirez-Vazquez, R., Escobar, I., Vandenbosch, G. A., & Arribas, E. (2024). Personal exposure to radiofrequency electromagnetic fields: A comparative analysis of international, national, and regional guidelines. *Environmental Research*, *246*, 118124. https://doi.org/10.1016/j.envres.2024.118124

[19] Samaila, B., Abdullahi, A. H., Yahaya, M. N., & Abubakar, N. (2023). Residential exposure to non-ionizing electromagnetic radiation from mobile base stations: a systematic review on biological effects assessment. *Material Science & Engineering International Journal*, *7*(2), 44–52. https://doi.org/10.15406/mseij.2023.07.00203

[20] Solomon, E. M., & Van Klyton, A. (2020). The impact of digital technology usage on economic growth in Africa. *Utilities Policy*, *67*, 101104. https://doi.org/10.1016/j.jup.2020.101104

[21] Tuieng, R. J., Cartmell, S. H., Kirwan, C. C., & Sherratt, M. J. (2021). The effects of ionising and Non-Ionising electromagnetic radiation on extracellular matrix proteins. *Cells*, *10*(11), 3041. https://doi.org/10.3390/cells10113041

[22] Ugweje, O. C. (2004). Radio frequency and wireless communications. *The Internet Encyclopedia*. https://doi.org/10.1002/047148296x.tie151