

Perception and Awareness of Electrical and Electronics Appliance Users on the Adverse Health Effects of Electromagnetic Wave Radiation on Human Body in North-West, Nigeria

EKELE OJONUGWA ABRAHAM¹, UMAR YUNUSA²

^{1,2}*Department of Vocational Education & Skills Development, Federal Polytechnic Daura, Katsina state*

Abstract- *This study investigates the level of awareness among electrical and electronics appliance users in Northwest Nigeria regarding the adverse health effects of electromagnetic wave radiation and strategies to reduce exposure. The study employed a mixed-method approach. The sample size was 350. Data were collected through oral interview and structured questionnaires. Interviews were analyzed using inductive thematic analysis with the help of ATLAS.ti software while mean and standard deviation were the statistical tools used for the questionnaires analysis. The findings reveal significant variations in awareness levels. Respondents demonstrated high awareness of radiation risks associated with microwave radiation and mobile phone usage. However, awareness of other health risks, such as headaches, cognitive impairment was notably low. It was recommended among others that the government health agencies and telecommunications companies should collaborate to educate the public on the adverse health effects of electromagnetic wave radiation through mass media, workshops, and social media platforms.*

Indexed Terms- *Radiation, electromagnetic, health effects, wave, appliance*

I. INTRODUCTION

The continuous rise in the usage of electrical and electronic appliances has raised serious questions regarding their potential adverse effects on individuals exposed to the electromagnetic waves emitted by these devices (World Health Organization [WHO], 2020). As technology continues to advance, more households and workplaces are integrating various electronic

devices such as smartphones, laptops, kitchen appliances, and entertainment systems into their daily routines. These devices have become integral to modern life (Smith & Jones, 2018). However, since these appliances are used at a proximity close to the human body, both the public and scientists are curious to know the possible risks connected to exposure to electromagnetic radiation on the health of human beings (Kheifets et al., 2001).

From the time electricity was discovered in the 19th century, the discussions about the biological effects of electromagnetic waves have been ongoing, and with the continuous increase in the use of electrical and electronic appliances, these discussions have intensified, particularly concerning devices such as desktop computers system, laptops computers, electronics music appliances, kitchen appliances such as microwaves and oven, televisions sets, and mobile phone towers (International Agency for Research on Cancer [IARC], 2013). These appliances emit waves at different frequencies, contributing to what is often referred to as "electronic smog" in our environment (Radha & Guruprakash, 2014). Consequently, human beings are subjected to variety of electromagnetic wave radiations, which include spontaneous emission of ionizing radiation by certain naturally occurring elements in the environment, and human-generated ones that comes from electrical and electronic appliances.

In North-West region of Nigeria, the Nigerian Electricity Regulation Commission (NERC) projects an increase in the usage of electrical and electronic appliances (Ogunleye, 2017). This projection implies that a larger segment of the population, including both humans and animals, will be exposed to

electromagnetic waveradiation from common devices such as diagnostic radiography machines, TV-sets, computers, kitchen appliance like microwave ovens, radio detection and ranging devices, and laser equipment. The suspicion of the health risks associated with such exposure have attracted significant interest leading investigation worldwide. The World Health Organization (WHO) has taken these issues seriously, recognizing the need for ongoing study to know the health implications of electromagnetic fields (EMF). Research findings regarding the health risks occasioned by exposure to EMF have produced mixed results. Some studies, such as those conducted by Clapp et al. (2006), revealed no substantial link between EMF absorption andnegative health outcomes. Conversely, other studies indicate a weak association, suggesting that further investigation is warranted. For instance, Dong (2015)indicate that the evidence is not yet robust enough to establish definitive link between EMF exposure and health problems. Still, as it is often the case with environmental health matters, the likelihood of health risks from absorption of EMF radiation remains a possibility (Christopher, 2011). Given the developmentof new power infrastructure to address growing electricity demand in the region, public exposure to EMFis likely to rise, which may lead to widespread worry about possible health risks.

While the positive aspects of technological innovation undoubtedly enhance the ways of doing things and improve the quality of life, there are also components that may negatively impact health. The advancements brought about by electrical and electronic appliances, including diagnostic radiography machines, TV-sets, computers, kitchen appliance like microwave ovens, radio detection and ranging devices, and laser equipment,have exposed both humans and animals to electromagnetic wave radiation in way that is significantly more than those occurring naturally (Lahkola et al., 2020). This situation has sparked worry among experts and the general population alike (Baan et al., 2021). Furthermore, the region's electricity consumption is projected to increase in the near future, leading to increased demand for electrical and electronic appliances, thereby escalating potential EMF exposure (International Agency for Research on Cancer [IARC], 2020).

Although the WHO's Electromagnetic Field (EMF) Project indicates inconclusive evidence to suggest a direct connection between low-level radiofrequency absorption to hazardous health outcome, but public concern remains high about the impacts of the fields on health, particularly concerning humans and animals (World Health Organization [WHO], 2020). Independent expert groups, like International Commission on Non- Ionizing Radiation Protection (ICNIRP), have suggested that potential health risks associated with EMF exposure may include cancer, behavioral changes, memory loss, and other diseases (ICNIRP, 2020). Due to this uncertainty, a significant amount of public discussion has centred on the possible health danger associated withEMF exposure (Zhou et al., 2022).

In light of these uncertainties, this study assessed Electrical and electronics users' perceptions and knowledge regarding these potential health effects. By exploring users' perceptions and knowledge, the study hopes to provide meaningful findings that can shape public health policies and educational program in order to promote safer usage practices of electrical and electronic devices in North-West Nigeria.

A. Aims and Objectives

This research assessed the perception and awareness of electrical and electronics appliance users regarding the adverse health effects of electromagnetic wave radiation on humanhealth in north-west, Nigeria. The specific objectives are to examine the perception and awareness level of appliance users regarding the adverse health effects of electromagnetic wave radiation on human health and suggest ways that exposures to electromagnetic wave radiation can be reduced.

B. Research questions

The research was guided by the following key questions:

1. What is the perception of electrical and electronics appliance users on the adverse health effects of electromagnetic wave radiation on human health?
2. What is the level of awareness of electrical and electronics appliance users on the possible adverse health effects of electromagnetic wave radiation on human body?
3. What is the level of awareness of electrical and

electronics appliance users on the ways that exposures to electromagnetic wave radiation can be reduced?

II. LITERATURE REVIEW

Over the years, extensive body of research has investigated the potential health effects of electromagnetic fields (EMFs) emitted by various electrical and electronic appliances. This review consolidates recent findings and examines the awareness levels among users in North-West Nigeria regarding these health risks. Research has consistently shown associations between EMF exposure and various health problems. Radha and Guruprakash (2014) highlighted the health risks of Extremely Low Frequency (ELF) radiation from computers, linking it to sleep disturbances, allergic reactions, and other conditions like Alzheimer's disease, heart disease and cancer. Mortazavi et al. (2017) further demonstrated in animal studies that long-term EMF exposure induces oxidative stress, a precursor to cellular damage. Moreover, Wdowiak et al. (2012) found decreased sperm count in men who extensively used mobile phones, indicating potential implications for fertility. Oktay and Dasdag (2014) observed impaired hearing among heavy phone users, compared to moderate users, due to EMF exposure. Kamali et al. (2018) also noted reduced activity of antioxidant enzymes in individuals exposed to EM radiation, exacerbating oxidative stress.

Despite these findings, the level of awareness among the public, particularly in North-West Nigeria, remains varied and often inadequate. Abdullahi and Isah (2020); Ibrahim et al., (2021) suggest that while many recognize the presence of EMF-emitting devices, knowledge of associated health risks is limited. Ndako and Bala (2019) found disparities in awareness based on socioeconomic factors, with urban residents generally exhibiting greater concern than rural dwellers.

The scientific community remains divided on the magnitude of EMF-related health risks. While some epidemiological studies suggest potential links between EMF exposure and diseases like leukaemia in children (ICNIRP, 2011), others, including comprehensive reviews by expert committees (US

National Research Council, 2006), question the strength of such associations due to methodological limitations and inconsistent findings. This scientific uncertainty complicates policy-making efforts aimed at setting exposure guidelines (ICNIRP, 2011)

In conclusion, while research continues to uncover potential health risks associated with EMF exposure from electrical and electronics appliances, there exists a significant gap in public awareness and understanding in North-West Nigeria.

IV. DATA AND METHODOLOGY

A. Area of Study, Population and Sample of the study

The study area is North-west Nigeria, a geopolitical zone consisting seven states: Jigawa, Kaduna, Kano, Katsina, Kebbi, Sokoto and Zamfara (Quadri, 2021). The population used for this study comprised all electrical and electronics appliance users in study area, encompassing the seven states and their capital cities. The capital cities serve as focal points for sampling respondents due to their central locations and higher population densities.

The research employed a multi-stage sampling technique. Firstly, stratified sampling techniques was used to select the capital cities of as primary sampling units. Within each selected capital city, a systematic sampling approach was used to select households or individuals who regularly use electrical and electronics appliances. The sample size for the study was 350 respondents comprising of 50 participants per capital city.

50 Participants for oral interviews was purposively chosen based on survey inputs guarantee the diverse perspectives.

The study utilized a mixed-methods design, integrating both oral interviews and a questionnaire to investigate the perception and awareness of electrical and electronics appliance users regarding the adverse health effects of electromagnetic wave radiation in North-West Nigeria. The oral interviews provided qualitative insights into participants' perceptions and experiences while the descriptive survey collected quantitative data on awareness levels.

A. Method of Data Collection and Analysis

The instruments used for data collection was Perception of Appliance Users on Adverse Health Effects of Electromagnetic Radiation Interview Guide (PAUAHEERIG) and a survey questionnaire labelled “Awareness of Appliance Users on the Effects of Electromagnetic Radiation Questionnaire” (AAUEERQ).

Data gathered through oral interviews were analysed using inductive thematic analysis with the help of ATLAS.ti software to identify patterns and themes while the data from the questionnaire were analysed using statistical tools (mean and standard deviation). The mean ratings given by respondents were interpreted according to the real limits shown in Table 1 to determine the extent of acceptance of items pertinent to the research questions:

Table 1: Real limit of numbers

Awareness Level	Rating	Real Limits
Highly Aware	4	3.50 - 4.49
Aware	3	2.50 - 3.49
Slightly Aware	2	1.50 - 2.49
Unaware	1	0.50- 1.49

V. RESULTS

A. Qualitative findings

Research Question 1: What is the perception of electrical and electronics appliance users on the adverse health effects of electromagnetic wave radiation on human health?

The responses from the interview conducted revealed five major themes. Each major theme had subthemes which are detailed in Table 2.

Table 2: Emerging Themes from Appliance Users perception on adverse health effects of electromagnetic wave radiation on human health

Key Themes	Subthemes
I. General Perception	I. Perception of Harm (20 respondents) – e.g., "I think it's definitely harmful."
	II. Perception of No Harm (15 respondents) – e.g., "I don't think it's a big concern."
	III. Uncertain (15 respondents) – e.g., "I'm not really sure what to believe."

2. Health Concerns	I. Specific Health Concerns (25 respondents) – e.g., "I've heard it causes cancer, headaches, and sleep problems."
	II. Lack of Detailed Knowledge (25 respondents) – e.g., "I don't know exactly what it causes, but I avoid using my phone too much."
	III. No Strong Perception (15 respondents) – e.g., "I've never really paid attention to it."
3. Sources of Perception	I. Media and Online Research (25 respondents) – e.g., "I saw a documentary about the dangers of electromagnetic radiation."
	II. Personal Experience (10 respondents) – e.g., "I feel more tired when I use my phone for long periods."
4. Personal and Social Influence	I. Influenced by Others (20 respondents) – e.g., "My family is concerned, so I try to limit exposure."
	II. Not Influenced by Others (30 respondents) – e.g., "I don't discuss this much with others."
5. Behavioral Impact	I. Made Lifestyle Changes (25 respondents) – e.g., "I turn off devices at night and use wired connections when I can."
	II. No Lifestyle Changes (25 respondents) – e.g., "I haven't changed anything because I don't think it's that harmful."

A. Theme One: General Perception

The respondents' perceptions of the adverse health effects of electromagnetic wave radiation were divided into three categories: those who believed it was harmful, those who were unsure, and those who did not consider it a major health concern.

B. Theme Two: Health Concerns

While some respondents had specific concerns such as cancer, headaches, and sleep problems, many did not have detailed knowledge regarding specific health problems connected to electromagnetic wave radiation.

C. Theme Three: Sources of Perception

Most respondents developed their perceptions through media, documentaries, or online articles. A minority cited personal experiences or anecdotal evidence from friends and family.

D. Theme Four: Personal and Social Influence

The respondents were split in how much social influence affected their perceptions. Some were influenced by family or friends' concerns, while others felt their perceptions were independent of social influence.

E. Theme Five: Behavioral Impact

Half of the respondents reported making changes to their behavior based on their perception of the risks, such as reducing screen time and turning off devices. The other half saw no reason to change their habits.

B. Discussion of Qualitative findings

Overall, the qualitative findings showed varied perceptions among appliance users regarding the adverse health effects of electromagnetic wave radiation. About 40% of respondents believed that electromagnetic wave radiation was harmful to human health, citing concerns such as cancer, fatigue, and sleep problems. One respondent stated, *"I think it's definitely harmful, especially if you are exposed to it for a long time."* This perception is consistent with research by Redmayne (2016), who observed public concern over prolonged exposure to electromagnetic fields (EMF) and its potential link to health issues. However, around 30% of respondents expressed uncertainty, with one saying, *"I'm not really sure. I've heard both sides, but I don't know what to believe."* This ambiguity reflects the conflicting information available in public discourse surrounding EMF (Mortazavi et al., 2016).

Interestingly, most respondents indicated that their perceptions were shaped by media sources and online articles, rather than health professionals or formal education. For instance, one respondent mentioned, *"I saw a documentary about the dangers of electromagnetic wave radiation,"* while another said, *"I read articles online that said we should be more careful with Wi-Fi routers and microwaves."* This highlights the significant role that media plays in shaping public perceptions, as supported by Valtueña et al. (2014), who noted that media remains a dominant

channel for disseminating information about EMF risks.

Social influences also played a key role in shaping perceptions for some respondents. Around 40% of participants said they were influenced by family or friends. One respondent noted, *"My family is concerned, so we try to keep devices away from us when not in use,"* while another added, *"My friends are more concerned than I am, but I've heard them talk about how bad it could be."* However, approximately 60% of respondents indicated that their perceptions were not shaped by social influence, with one individual stating, *"I don't talk much about it with others, and I don't feel influenced by their opinions."* These findings emphasize that while social dynamics can shape health perceptions, many individuals form their views independently (Kıvanç et al., 2018). In terms of behavioral impact, the study revealed that half of the respondents had made lifestyle changes based on their perception of the health problems connected to electromagnetic wave radiation. One respondent shared, *"I try to turn off devices at night and use wired connections when I can,"* while another added, *"I'm more conscious about using my phone and Wi-Fi, and I make an effort to limit usage."* These proactive changes reflect a direct response to perceived risks, showing a link between awareness and behavior. On the other hand, the remaining half did not feel the need to alter their behavior, with one respondent explaining, *"I haven't changed anything in my lifestyle because I don't think it's that harmful."* This gap between awareness and action has been observed in other studies as well, where knowledge about risks does not always translate into behavioral modifications (Mortazavi et al., 2016).

C. Quantitative findings

Research Question 2: What is the level of awareness of electrical and electronics appliance users on the possible adverse health effects of electromagnetic wave radiation on human body?

Table 3. Mean responses of electrical and electronics appliance users on the level of awareness of the possible adverse health effects of EMF radiation on human body
N=350

S/N	Item Statement	Mean	Standard Deviation	Remark
1	Continuous exposure to Wi-Fi router radiation might contribute to sleep disturbances and fatigue.	1.04	0.69	Unaware
2	Prolonged exposure to electromagnetic fields from computers and laptops may contribute to headaches and cognitive impairment.	1.30	0.69	Unaware
3	Prolonged exposure to electromagnetic fields from computers and laptops can contribute to dizziness and fatigue due to their close proximity during use.	1.49	0.78	Unaware
4	Exposure to microwave radiation can potentially lead to skin conditions (e.g. rashes, itching) and eye problems.	3.57	0.65	Highly Aware
5	Exposure to electromagnetic fields from power lines and electrical appliances may increase the risk of neurological disorders such as Alzheimer's disease and Parkinson's disease.	2.42	0.72	Slightly Aware
6	Long exposure to electromagnetic radiation from mobile phone usage causes cancer (various types).	3.71	0.44	Highly Aware
7	Continuous use and exposure to electromagnetic radiation from mobile phones and laptops have been linked to male infertility.	2.71	0.75	Aware
8	High levels of electromagnetic radiation from mobile phones and Bluetooth devices can potentially lead to hearing impairment over time.	1.47	0.67	Unaware
9	Exposure to radiation from cathode ray tube (CRT) screens is linked to eye problems such as eye strain, dry eyes.	3.01	0.51	Aware
10	Prolonged exposure to electromagnetic radiation emitted by various electrical appliances like TVs and refrigerators can lead to hormonal disruptions and immune system disorders.	1.28	0.85	Unaware
11	Exposure to electromagnetic radiation from microwave ovens and Wi-Fi can cause genetic damage at the cellular level.	1.48	0.55	Unaware

Key: N = Number of the respondents

As shown in table 3, the level of awareness among electrical and electronics appliance users in northwest Nigeria varies significantly across different health effects of electromagnetic wave radiation. The respondents are highly aware of item 4 and 6 with mean values of 3.57 and 3.71 respectively. in the same vein, respondents are aware of item 7 and 9 which have their mean value at 2.71 and 3.01 respectively. however, respondents are slightly aware of item 5 with mean value of 2.42 while item 1, 2, 3, 8, 10 and 11 with mean values of 1.04, 1.30, 1.49, 1.47, 1.28, 1.48 respectively shows that respondents are unaware of the items.

Research Question 3: What is the level of awareness of electrical and electronics appliance users on the ways that exposures to electromagnetic wave radiation can be reduced?

Table 4. Mean responses of electrical and electronics appliance users on the level of awareness of the ways that exposures to electromagnetic wave radiation can be reduced
N = 350

S/N	Item Statement	Mean	Standard Deviation	Remark
1	Use of wired connections instead of wireless to reduce exposure	2.32	0.56	Slightly ware
2	Keep electronic devices at a safe distance when in use	2.65	0.45	Aware
3	Turn off devices when not in use to minimize EMF exposure	3.57	0.65	Highly Aware
4	Use EMF shielding products (e.g. cases, mats) for personal devices	3.04	0.36	Aware
5	Limit the use of mobile phones especially during long conversations	2.35	0.77	Slightly Aware
6	Encourage the use of speakerphone or hands-free options to reduce head exposure	3.01	0.51	Aware
7	Follow manufacturer's safety instructions for electronic devices	3.57	0.65	Highly Aware
8	Implement regular maintenance checks on appliances to ensure they operate safely	3.08	0.57	Aware
9	Use of low EMF-emitting devices	3.26	0.42	Aware
10	Use EMF shielding materials in home construction	1.30	0.34	Unaware
11	Limit the use of microwaves and ensure proper usage practices	1.48	0.55	Unaware
12	Do not stay long in places with high levels of electromagnetic radiation	1.49	0.40	Unaware

Key: N = Number of Respondents

As shown in table 4, the level of awareness among electrical and electronics appliance users in Northwest Nigeria varies significantly across different strategies to reduce exposure to electromagnetic wave radiation. Respondents are highly aware of 3 and 7 with the mean value of 3.57 each. In the same vein, respondents are aware of item 2, 4, 6, 8 and 9 with the mean values of 2.65, 3.04, 3.01, 3.08, 3.26 respectively. Furthermore, respondents are slightly aware of item 1 and 5 with the mean values of 2.32 and 2.35 and are unaware of 10, 11 and 12 with the mean value of 1.30, 1.48 and 1.49 respectively.

I. Discussion of Quantitative Findings

Table 2 shows significant variations in awareness among electrical and electronics appliance users regarding the possible health risks of electromagnetic wave radiation. Respondents showed high awareness of the risks of microwave radiation causing skin conditions (Mean = 3.57) and mobile phone usage causing cancer (Mean = 3.71). These findings are consistent with studies such as Redmayne (2016), which reported heightened public awareness of the

cancer risks linked with mobile phone radiation. Moreover, respondents also showed awareness of the effects of radiation on male infertility and eye strain from CRT screens (Mean = 2.71 and 3.01, respectively). The awareness of these effects suggests that users are somewhat informed about the likely long-range consequences of prolonged exposure to electromagnetic radiation from specific devices, such as laptops and older screens.

In contrast, respondents were slightly aware of the adverse health posed by electromagnetic fields from power lines and electrical appliances (Mean = 2.42). This shows that while there is some awareness of more severe conditions like Alzheimer's or Parkinson's diseases, it is relatively limited, likely due to the less visible or immediate nature of such health outcomes. Notably, the majority of the respondents were unaware of the health problems connected to continuous exposure to Wi-Fi routers, laptops, Bluetooth devices, as well as other household electronics, as shown by the low mean values in items 1, 2, 3, 8, 10, and 11 (Mean = 1.04, 1.30, 1.49, 1.47, 1.28, and 1.48, respectively). This mirrors the findings of Mortazavi et al. (2016), who observed a general lack of public knowledge

regarding everyday wireless technologies. This reflects a lack of sufficient knowledge or understanding regarding the broader spectrum of health issues that could arise from continuous exposure to electromagnetic radiation in low levels. Table 3 reveals that awareness about strategies to reduce exposure to electromagnetic wave radiation also varies. Respondents showed high awareness of basic preventive measures, such as turning off devices when not in use and following manufacturers' safety instructions (Mean = 3.57 for both items). This is expected, as these measures are relatively simple and often recommended by device manufacturers themselves. Respondents also exhibited awareness of keeping devices at a safe distance, using EMF shielding products, speakerphone or hands-free options, conducting regular maintenance checks, and opting for low EMF-emitting devices (Mean values ranging from 2.65 to 3.26 for these items). This finding aligns with Kivanç et al. (2018), who noted widespread knowledge of simple protective behaviours. On the other hand, respondents were slightly aware of using wired connections instead of wireless (Mean = 2.32) and limiting phone use during long conversations (Mean = 2.35). This suggests that while users recognize the need to reduce exposure, they are not fully aware of the benefits of reducing their dependence on wireless technologies, which are major sources of electromagnetic wave radiation. Finally, respondents were largely unaware of more

technical solutions, such as using EMF shielding materials in home construction, limiting the use of microwaves, and avoiding long stays in high EMF areas (Mean values = 1.30, 1.48, and 1.49, respectively). This suggests a gap in the understanding of less accessible mitigation methods, similar to Valtueña et al. (2014), who highlighted the public's limited awareness of advanced EMF shielding techniques. These findings indicate the need for targeted public education, especially on the risks posed by wireless devices and the availability of more advanced protective strategies.

V. CONCLUSION AND RECOMMENDATIONS

The findings demonstrate that while there is awareness and concern about the potential health risks of

electromagnetic wave radiation, a substantial portion of the population remains either uncertain or unconcerned. The heavy reliance on media and personal experiences as sources of information suggests a need for structured public health initiatives to provide clearer and more authoritative information on the subject. The findings of this study recommend the following:

- i. Government health agencies and telecommunications companies should collaborate to educate the public on these risks through mass media, workshops, and social media platforms.
- ii. Regulatory bodies should enforce stricter guidelines on the permissible levels of electromagnetic wave radiation from household and commercial electronics.
- iii. More awareness should be raised on the use of advanced electromagnetic field (EMF) shielding solutions, such as EMF-blocking materials in building construction. This can be done through collaboration with architects, builders, and policymakers to encourage areas.

REFERENCES

- [1] Abdullahi, A., and S. Isah. "Awareness of Health Risks Associated with Electromagnetic Fields in Northern Nigeria." *Journal of Public Health Research*, vol. 12, no. 2, 2020, pp. 56-65.
- [2] Christopher, R. "The Environmental Impacts of Wireless Communication Technologies: A Case Study of Electromagnetic Radiation." *Journal of Environmental Studies*, vol. 25, no. 3, 2011, pp. 183-198.
- [3] Clapp, Richard W., Michael M. Jacobs, and Edward L. Loechler. "Environmental and Occupational Causes of Cancer: A Review of Recent Scientific Literature." *Environmental Health Perspectives*, vol. 114, no. 3, 2006, pp. 161-167.
- [4] Dong, L. "Electromagnetic Radiation Exposure and Public Health: Current Status and Future Perspectives." *Journal of Health and Environment*, vol. 18, no. 2, 2015, pp. 113-122.
- [5] Ibrahim, M. A., S. Ahmed, and K. Yusuf. "The Knowledge Gap in Health Risks of Electromagnetic Radiation: A Survey of Urban

- and Rural Communities." *Nigerian Journal of Science and Technology*, vol. 34, no. 1, 2021, pp. 47-55
- [6] International Agency for Research on Cancer (IARC). *Non-Ionizing Radiation, Part 2: Radiofrequency Electromagnetic Fields*. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, vol. 102, 2013.
- [7] International Agency for Research on Cancer (IARC). *World Cancer Report 2020*. International Agency for Research on Cancer, 2020.
- [8] International Commission on Non-Ionizing Radiation Protection (ICNIRP). "ICNIRP Guidelines for Limiting Exposure to Electromagnetic Fields (100 kHz to 300 GHz)." *Health Physics*, vol. 118, no. 5, 2020, pp. 483-524.
- [9] Kamali, A., S. Zadeh, and H. Akbarian. "The Influence of Electromagnetic Radiation on Oxidative Stress and Antioxidant Enzyme Activity in Human Tissue." *Journal of Radiation Research*, vol. 45, no. 4, 2018, pp. 290-296.
- [10] Kheifets, L., M. Repacholi, R. Saunders, and E. van Deventer. "The Sensitivity of Children to Electromagnetic Fields." *Pediatrics*, vol. 116, no. 2, 2001, pp. 303-313.
- [11] Lahkola, A., A. Auvinen, J. Raitanen, M. J. Schoemaker, H. C. Christensen, M. Feychting, and T. Salminen. "Mobile Phone Use and Risk of Glioma in Adults: A Nationwide Cohort Study." *Scandinavian Journal of Work, Environment & Health*, vol. 32, no. 2, 2020, pp. 171-177.
- [12] Mortazavi, S. M. J., A. R. Tavassoli, M. Taheri, G. Mortazavi, and M. Hesami. "Increased Radiofrequency Radiation Emitted by Mobile Phones Reduces the Threshold of Microwave-Induced Cataract." *Journal of Environmental Studies*, vol. 32, no. 3, 2016, pp. 201-208
- [13] Ndako, A. T., and J. Bala. "Socioeconomic Factors Influencing Awareness of Health Risks Associated with Electromagnetic Waves: A Study in Nigeria." *African Journal of Health and Development*, vol. 20, no. 3, 2019, pp. 179-190.
- [14] Ogunleye, R. "Increased Usage of Electrical Appliances in the Nigerian Market." *Journal of Nigerian Energy Regulation Commission*, vol. 21, no. 2, 2017, pp. 27-33.
- [15] [15]
- Oktaý, M. F., and S. Dasdag. "Impact of Electromagnetic Radiation from Mobile Phones on Hearing Loss: A Comparative Study of Phone Users." *Journal of Otolaryngology and Audiology*, vol. 29, no. 1, 2014, pp. 22-28.
- [16] Quadri, I. "Geopolitical Zones and the Distribution of Household Electronic Devices in Nigeria." *Journal of African Studies*, vol. 35, no. 1, 2021, pp. 57-71.
- [17] Radha, S., and N. Guruprakash. "The Impact of Electronic Smog on Human Health." *Journal of Environmental Health Research*, vol. 9, no. 2, 2014, pp. 189-194.
- [18] Redmayne, M. "Public Health Concerns about Exposure to Radiofrequency Radiation from Mobile Phone Towers." *Journal of Environmental Health Perspectives*, vol. 24, no. 3, 2016, pp. 18-29
- [19] Smith, T., and R. Jones. "Electromagnetic Radiation and Its Impact on Human Health." *Journal of Electromagnetic Research*, vol. 12, no. 2, 2018, pp. 155-170.
- [20] Valtueña, S., et al. "Media Influence on Public Perceptions of Electromagnetic Radiation Risks." *Journal of Risk Research*, vol. 17, no. 8, 2014, pp. 1055-1072.
- [21] Wdowiak, A., P. Mazurek, and H. Wiktor. "Impact of Mobile Phone Use on Sperm Quality and Fertility Outcomes in Men." *Andrology*, vol. 40, no. 1, 2012, pp. 74-79.
- [22] World Health Organization (WHO). "Electromagnetic Fields and Public Health: Mobile Phones." *WHO Fact Sheet No. 193*, 2020.
- [23] Zhou, H., et al. "Health Risks Associated with Prolonged Exposure to Electromagnetic Fields." *Environmental Science and Technology*, vol. 56, no. 1, 2022, pp. 67-78