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Full Length Research Article

A STUDY ON ELECTROMAGNETIC FIELD/RADIATION PRODUCED BY HOUSEHOLD DEVICES IN JALINGO LOCAL GOVERNMENT AREA, TARABA STATE, NORTHEASTERN NIGERIA

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ABSTRACT
In this work, we measured the Electromagnetic Field (EMF) from some electronic household devices using an Electromagnetic Field Radiation Tester Model: EMF-832. The study was conducted in Jalingo Local Government Area, Taraba State, Northeastern Nigeria, across multiple households to assess background radiation levels and EMF emissions from household appliances. The findings indicate that high electric coiled devices, such as microwave ovens and voltage regulators, are potential sources of significant EMF exposure. Measurements show that the microwave oven emits the highest EMF, approximately 100 μT at zero separation, while mobile phones emit significantly lower levels. We also observed a decline in EMF strength with increasing distance from the source. The study further includes an analysis of the background radiation in the study area, which was found to be within permissible exposure limits. Understanding the level of EMFs emitted from household appliances will help in implementing precautionary measures to mitigate long-term exposure risks and maintain an electromagnetic frequency-safe home.

Keywords: Electromagnetic-field radiation, microwave oven, mobile phone, radio receiver

INTRODUCTION

For the past four decades, the biological effects of Electromagnetic Fields (EMFs) have become a source of public concern. EMFs, which are combinations of electric and magnetic fields, are produced by electrically charged objects and exist naturally in the environment. However, modern technological advancements have significantly altered this natural balance, introducing a wide array of artificial EMF sources into our daily lives. According to Adey (1993), life on Earth evolved in a sea of natural EMFs, which have now been altered by man-made sources such as power lines, household appliances, and telecommunications infrastructure. Karki (2017) asserts that EMFs are part of the non-ionizing spectrum emitted by electrical devices and appliances that can potentially disturb human health. Hence, a lot of advocacy and research sponsored by the World Health Organization (WHO) and other health agencies across the world is been carried out to ascertain the short, medium, and long-term exposure effects on human health to various EMF frequencies.

Power frequency EMFs have been in use in industrialized countries since the introduction of public electricity supplies in the late nineteenth century (Kheifets *et al*., n.d.). Today, the increase in cellular communication and other technological advancements has increased the level of human exposure to EMF. Industries, Radio Base Stations, and power stations are no longer the only sources of EMFs; we encounter EMFs in our homes, offices, hospitals, and public gatherings. In our day-to-day usage of electrical appliances such as televisions, voltage regulators, microwave ovens, and cellular phones, we are exposed to different levels of EMF. Although there are still scant reports on the health effects of EMFs, the location of cellular mobile communication stations at least three kilometers apart by different network providers in residential areas is alarming, as we will soon be swimming in pools of EMFs.

The range of EMFs varies, depending on the frequency of operation of the source. There are four frequency ranges based on which EMF sources, namely: (a) static sources having a frequency of 0 Hz. (b) Extremely Low Frequency (ELF) EMF from power lines having a frequency range from 0 – 300Hz. (c) Intermediate Frequency (IF) EMF sources with frequencies ranging from 300Hz – 100KHz (examples of these sources include card readers and metal detectors). (d) Radio Frequency (RF) with operating frequency ranges from 100 KHz – 300GHz. Microwave ovens, Radar, and cellular communication devices are in this range. Much research now is being focused on magnetic than electric fields and its effect on childhood leukemia (Ahlbom et al., 2000). Adults living within fields of 50 metres or less to power transmission lines have 33% risk of contracting leukemia, higher than ones living from 50 – 100 metres away from the power lines (Ögel *et a*l., 2010). Since the EMF from power lines does not penetrate buildings, people may be at risk only when they are outdoors.

According to Karki (2017), one of the major problems of the present digital age is electromagnetic pollution. For houses and offices, the average magnetic field level limit is about 100μT (Coleman *et al.,* 1989; Olden, 1999). The 100μT recommended by the International Non-ionizing Radiation Committee for the general public is above 0.4μT, the limit considerably associated with the risk of having leukemia in childhood (Ögel et al., 2010). A number of adverse health effects associated with Extremely Low Frequency (ELF) of about 0.3 to 0.4μT include childhood cancer in adults, depression, cardiovascular disorder, developmental disorder , and immunological modification have been reported (Deford & Gandhi, 1985; Greenland *et al*., 2001; Protection, 2010). Epidemiological studies have shown that EMF is associated with childhood cancers such as leukemia and melanoma (Yalçın & Erdem, 2012). Although no accepted mechanism have been established to explain how exposure to ELF electromagnetic fields could lead to leukemia, Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) asserts that, the previous conclusion that ELF magnetic fields are carcinogenic chiefly based on childhood leukemia results is still valid (SCENIHR), 2007). According to the International Agency for Research on Cancer (IARC), ELF electromagnetic field classification as possibly carcinogenic is based on available epidemiological data for childhood leukemia but lacks evidence from laboratory studies in animals and cells (BOICE

JR, 2006; Hardell & Sage, 2008; Tomitsch & Dechant, 2015).

The alternating current used in homes in most countries has a frequency of 50Hz. This has become the dominant frequency for the EMFs found in most homes and offices (Calabrò & Magazù, 2010). Hence, the ELF electromagnetic field is the one predominant in homes and offices. Sandström (2006) opines that the exposure of office workers to EMFs is still minimal. Today, almost every home is contaminated with one form of EMF or the other. The major sources of EMFs in the home are electric fans, microwave ovens, voltage regulators, Cathode Ray Televisions, and other electromagnetic devices. Though there are many health risks that have been scientifically established to be associated with EMFs, it cannot be said that EMFs are health-friendly. For safety in our homes, it is important to monitor the level of radiation emitted by various appliances in the home and their range to avoid too long exposure, which could lead to health hazards. (Chukwuka, n.d.) conducted a comprehensive study to measure electric and magnetic fields in the intermediate-frequency (IF) range (300 Hz to 1 MHz) emitted by household appliances in 42 residences across Belgium, Slovenia, and the UK. The findings revealed that although general exposure levels in homes were low, some appliances, particularly induction cookers and compact fluorescent lights, could produce higher levels of exposure when used at close distances (20 cm). There were no emissions measured that exceeded the safety guidelines set by the International Commission on Non-Ionizing Radiation Protection. The research contributes valuable data for understanding potential health effects related to IF exposure from common household devices. This work therefore reports the amount of EMF in selected household electrical appliances.

The present study was carried out in Jalingo Local Government Area of Taraba State, Northeastern Nigeria, an urban and semi-urban setting experiencing rapid infrastructural and technological development. The aim is to assess the EMF levels emitted from household appliances and compare them with established safety thresholds. Additionally, the study measured the background radiation in the environment to understand the cumulative EMF exposure residents may face in typical home settings.

This assessment is critical for raising awareness among local populations, especially in regions like Jalingo, where regulatory oversight and public education on EMF safety may be limited. The findings of this research provide a data-driven basis for practical recommendations, such as maintaining safe distances from appliances and adopting shielding measures where necessary

MATERIALS AND METHODS

The study was conducted in Jalingo Local Government Area, Taraba State, in Northeastern Nigeria. Jalingo is the capital city of Taraba State, characterized by a growing urban population, increasing use of electrical appliances, and expanding telecommunications infrastructure. The research involved measuring the average EMF levels in 25 homes, where various household appliances were tested for radiation emissions. Background radiation measurements taken across Jalingo indicate an average radiation level of 0.2 μT, which is within permissible exposure limits recommended by international safety guidelines. However, localized hotspots near power transformers and base stations recorded slightly elevated EMF levels.

The Electromagnetic Field Radiation Tester Model: EMF-832 was used to measure EMFs emitted by household appliances. The tester was placed in contact with each device, and EMF levels were recorded. Measurements were taken at increasing distances using a meter rule until radiation was no longer detectable. Additionally, background radiation levels were recorded using the same equipment to establish baseline exposure in the area.

Figure 1. Electromagnetic Field Radiation Tester Model: EMF-832 [19]

The tester was placed with its sensor in contact with the device, and the EMF measured. The distance was then varied with the aid of a meter rule from the device and the corresponding EMF values measured at various points from the device till the tester could no longer detect the radiation. The distance from the device to the least detectable radiation by the Tester is taken as the range of its emitted EMF. The home appliances used for this study were Cathode Ray Television (CRTV), Plasma Television (PTV), Cell phone (C-phone), Smart Phone (S-phone), Voltage Regulator (V.R), Electric Fan (E-Fan), Refrigerator (RFT), Radio Receiver (R-Receiver), Micro-Wave Oven (MWO), Electric Iron (E-Iron), Laundry Machine (L-Machine), Air Conditioner (A/C) and DVD Machine

RESULTS AND DISCUSSION

The values of the EMF emitted from the household appliances is presented in the Table 1

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Table 1: Variation of EMFs with distance

	EMF (μT)												
D (cm)	CRTV	P TV	C-phone	S-phone	V.R	E-Fan	RFT	R-Receiver	MWO	E-Iron	L-Machine	A/C	DVD
0	3.25	8.41	0.15	3.35	25.70	40.70	3.49	14.35	95.00	3.28	9.43	19.73	0.02
5	1.75	0.78	-	0.03	11.23	2.90	1.52	5.19	29.40	1.07	1.33	3.53	-
10	1.45	0.12	-	-	4.70	0.28	0.14	1.08	19.00	0.27	0.25	1.25	-
15	1.02	0.04	-	-	2.46	0.06	0.11	0.28	9.00	0.09	0.24	0.81	-
20	0.77	0.01	-	-	1.44	0.01	0.05	0.03	4.27	0.03	0.01	0.77	-
25	0.53	-	-	-	0.77		0.01	0.01	2.37	-	-	0.72	-
30	0.37	-	-	-	0.46		-	-	1.01	-	-	0.71	-
35	0.26	-	-	-	0.26		-	-	0.63	-	-	-	-
40	0.18	-	-	-	0.15		-	-	0.05	-	-	-	-
45	0.12	-	-	-	0.07		-	-	0.02	-	-	-	-
50	0.06	-	-	-	0.02		-	-	-	-	-	-	-

The microwave oven emitted the highest EMF of 95 μT at zero separation. The value of the EMF from the microwave oven decreases rapidly with increasing distance from the source. Next to the microwave oven is the electric fan, whose emission is almost half of that of the microwave oven. Afterward, there is a sharp decrease in the magnitude of the EMF as one moves away from the fan. The EMF emitted from voltage regulators decreases gradually from 0 to 20 cm, after which the decay in the radiation slows down as the distance increases. The EMFs emitted by the cathode ray television, air conditioner, radio receiver, laundry machine, plasma television, electric iron, cell phone, smartphone, and DVD player are the lowest, although their ranges vary.

Mobile phones radiate EMFs ranging from 0.15 – 3.5μT, depending on the nature of the phone [20]. The field dies within some few centimeters from their source. The usage of mobile phone encourages direct contact with the body. Though the radiations are short ranged, frequent and constant contact with the ear may be dangerous and long term exposure one spot of the body could be carcinogenic as predicted by recent research (Cancer, 2002). To avoid the effects of long time exposure, ear- piece and loud speakers should be encouraged when making calls and placing of mobile phones in pockets should be discouraged.

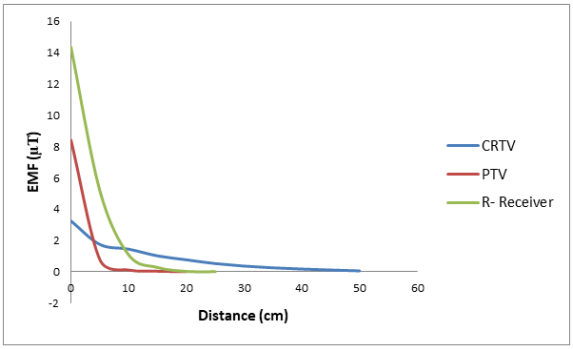

Figure 2: Variation of EMFs from cathode ray television, Plasma television and radio receiver with distance

Figure 2 is a comparison of the range of EMFs emitted by cathode ray television, plasma television and radio receiver. It is observed that, plasma television and radio receivers emit EMFs higher than cathode ray television. Also, the EMF emitted from cathode ray television travels longer distance than the plasma TV and radio receiver. The cathode ray television set is still in use in many homes in third world countries. Though the EMF from this device is not high, its range is wide, to avoid long term exposure, the cathode ray television should always be positioned at least half a metre from the user to avoid long term exposure.

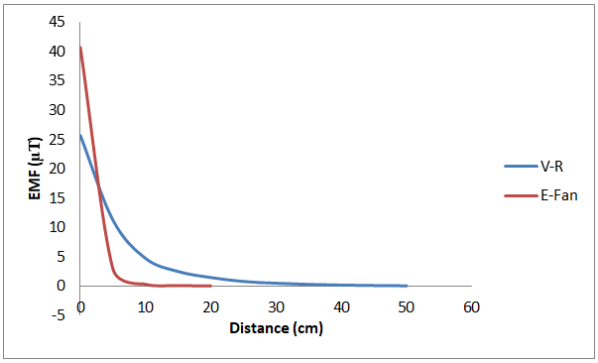

Figure 3: Variation of EMFs from voltage regulator and electric fan with distance

The variation of EMF and distance from voltage regulator and electric fan are compared in Fig. 3. Both devices are built with reasonable amount of electrical coil and are potential sources of EMF. Electric fan emits EMF of 40μT at zero separation while voltage regulator gives 25μT but there is a noticeable difference in the effective distance of about half a metre between these sources. The long range of EMF from the voltage regulator should be a source of worry to homes using it to stabilize voltage. However, to reduce the effect of long-term exposure, the voltage regulator can be placed at a far distance and extension cable used to link other appliances. If allowed to work simultaneously with other appliances at the same spot, the home would be concentrated with radiation from both the voltage regulator and the appliances and the range may likely increase.

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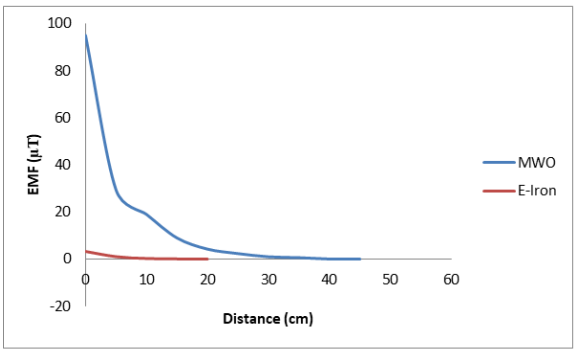

Figure 4: Variation of EMFs from micro-wave oven and electrical iron with distance

Both electric iron and micro-wave oven comprises of heating elements. The macro-wave oven emits EMF whose magnitude is about thirty times that emitted by the electric fan and covers an active distance which is three times longer than the electric fan (Fig. 4). The high EMF emitted from the micro-wave oven and the long distance they cover should be a point of concern to the modern kitchen users and caterers. However, the front face of the device happens not to emit the radiation; only the sides and the back face. To avoid long time exposure, the emitted radiation can be limited by operating the micro-wave oven from a well-designed cupboard, since EMFs have low penetrating power.

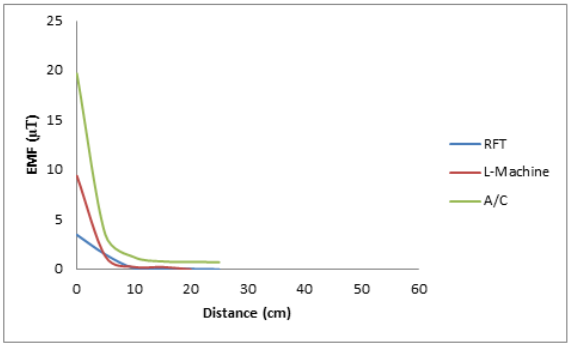

Figure 5: Variation of EMFs from refrigerator, laundry machine and air conditioner with distance

As seen in fig. 5, the refrigerator, laundry machine and air conditioner emit EMF radiation with short range and may not pose a serious exposure threat. All devices in fig. 5 emit radiation that lies within 20cm distance from their source.

Conclusion

This study focused on the background electric fields emitted from electrical appliance at home. Some appliances like macro-wave oven and voltage regulator emit a great amount of radiation with wide range that can circulate round a complete room if not fully checked. Leaving in such areas especially with children could be disastrous as studies in the literature showed that EMFs have been detected to be a major cause of childhood leukemia. Other appliances like the cathode ray television emit low EMFs with long ranges. Frequent and long term exposure to this radiation may lead to tissue excitation and discomfort. In some household appliances such as electric fan and air conditioner slightly high EMFs which is only active within some few centimeters are emitted and may not pose serious EMFs danger to homes because of the separation from users. Mobile phones emit very few EMFs that are short ranged, but our attitude in handling them could lead to its possible adverse effects over long term exposure. It is expected that knowledge of the level of EMFs emitted from the studied household appliances will help residents take every precautionary measures to enhance electromagnetic frequency free home.

The possible effects of EMFs to human health have being a topic of discussion in recent times. Electromagnetic frequency is present almost everywhere in our homes, offices and environments. In the home, various electrical appliances radiate different levels of EMFs. Some of these emitted EMFs can be neglected when compared with the total distance they cover while others cannot be under looked. This work compared the level of emitted EMFs from common home electrical appliances to the distances they cover after emission. The micro-wave oven gives out the highest EMF of up to 95μT at zero separation and covers a distance of 45cm. The cathode ray television do not emit high radiation, unfortunately, the EMF it emits do not die off even at 50cm away from it. Using other devices like voltage regulator to regulate the input voltage to devices such as cathode ray tube television and micro-wave oven may pose serious EMF pollution in the home. The higher EMFs emitted from the micro-wave oven can be minimized by increasing the size of its casing and operating the device from a well-designed cupboard that can shield the radiation. The background radiation levels in Jalingo were found to be within acceptable limits, but proximity to high EMF sources such as power lines and transformers could increase exposure risks. These findings highlight the importance of maintaining safe distances from high-EMF appliances and considering shielding strategies where necessary.

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