Assessment of ionizing radiation from electronics device in some selected viewing centers in Mubi, Adamawa State

K. G. Gaya* **and I. Yaratsada**

Department of Pure and Applied Physics, Adamawa State University, Mubi, Nigeria

***Correspondence:**
K. G. Gaya,
kennedygaya1@gmail.com

†**ORCID:**
K. G. Gaya
0009-0005-1329-193X

Today, the use of television as a tool in the work place, academic institutions, recreation facilities, homes, and sports viewing centers has become very common, it is estimated globally that people spend hours staring into a television monitor. This study aims to carry out an assessment on the ionizing radiation from the selected viewing centers in Mubi with a view to determine the possible safety exposure, absorbed radiation dose, and effective dose equivalent of the ionizing radiation from the television. Measurement was conducted using a radiation counter (Geiger Muller Counter) at a distance of 1, 1.8, 2.6, 3.4, 4.2, and 5.0 m, respectively. The absorbed dose, dose equivalent, and effective dose equivalent of Man-Tunkura, K. B. and T-Kurna sport centers were found to be 0.5741, 0.6964, and 0.6864 mGy; 0.0115, 0.0137, and 0.0139 Sv, and 0.0237, 0.0283, and 0.0287 Sv, respectively. The result obtained was compared with the ICRP standard safety lower limit for radiation protection, which falls far below the standard safety limit recommended. This implies that it is safe for people watching television with respect to the distance mentioned above.

Keywords: ionizing radiation, absorbed dose, effective dose equivalent, dose equivalent, radiation source, safety exposure

1 Introduction

Ionizing radiation emitted from electronic devices is a growing public health concern due to its ability to cause cellular damage and genetic mutations, potentially leading to cancer and other health issues. Although extensive research has predominantly focused on medical and occupational exposures, there is limited data regarding ionizing radiation levels stemming from consumer electronics in public communal spaces like viewing centers in Nigeria.

Studies within Nigerian university communities, such as measurements on television sets and computer monitors, have revealed that televisions generally emit higher levels of ionizing radiation compared to computer monitors, but these levels typically remain below the safety limits recommended by the International Commission on Radiological Protection

(ICRP) and World Health Organization (WHO) (1–5). The emissions depend on the type, age, and operating conditions of the devices, suggesting the importance of examining the specific devices used in viewing centers. The ability to ionize atoms and molecules is characterized in CRTs and high-voltage circuits that can emit low levels of ionizing radiation during operation (6).

Nevertheless, the radiation exposure levels for various body organs remained beneath the internationally established safe threshold of 1.0 mSv; consequently, the radiological health risk within the study region is relatively negligible, particularly in the short term (7–9). However, the regulatory bodies assume an essential function in the oversight of radiation safety; nevertheless, they encounter considerable obstacles, including constrained resources, insufficient infrastructure, and an urgent necessity

for public awareness. Recent advancements in these regulations encompass the amendment of safety protocols, collaborations with international organizations, and the integration of sophisticated monitoring technologies (10).

In assessing background radiation, investigations in health centers and hospital environments in Nigeria have shown that indoor and outdoor ionizing radiation levels mostly fall within internationally accepted standards. For example, at the University of Port Harcourt's health center, the observed annual effective dose equivalents were within safe limits, though some organ-specific doses, like those to the testes, were comparatively higher, emphasizing the need for ongoing monitoring (10). Similar assessments in radiological facilities across Nigerian cities such as Kano revealed gaps in radiation protection measures, highlighting insufficient shielding and safety protocols that could increase exposure risk for workers and the public if not properly controlled (11, 12).

Despite compliance with safety standards, the study by (13) noted higher emissions from televisions from the Dell and Toshiba brands, showing high levels of radiation, while Samsung devices were the safest. In as much as viewing centers, where individuals gather to watch sports for long durations, may pose health risks due to continually repeated exposure to radiation, particularly in an environment that is not or unguided with outdated technology (14), the need to determine the levels of such areas is of great importance.

The increasing prevalence of electronic devices in public viewing centers raises concerns about potential radiation exposure, necessitating thorough assessments to ensure safety and mitigate health risks. The assessment of ionizing radiation is crucial, particularly in environments where electronic devices are prevalent, as improper exposure can lead to significant health risks. This study aims to evaluate the levels of ionizing radiation emitted by electronic devices in selected viewing centers in Mubi, Adamawa State and provide the appropriate model for modeling the radiation of the selected viewing centers.

2 Study area

One of the most popular local governments in Adamawa State is Mubi, where residents spend their time watching football matches, which include the Premier League, La Liga, Bundesliga, Serie A, Champions League, and many more leagues and competitions to mention a few. Because Mubi is one of the hottest places in the state, this led to the study's emergence. The work, however, presents accessing the IR level in some selected television viewing centers.

3 Method of data collection

Materials used for measurement include GMC, measuring tapes, and televisions. Television sizes are 32, 40, 42, and 60″. In all viewing centers, the background radiation is first measured outside the viewing center before measurement. The measurements were conducted randomly in Man-Tunkura, K. B., and T-Kurna sports centers, with six data points per week, respectively. However, GMC does not measure specific types of ionizing radiation such as alpha, beta, or gamma particles, but generally measures IR.

3.1 Method of data analysis

This methodology combines physical dose measurement and epidemiological weight factors to provide a comprehensive assessment of radiation exposure and risk in the study areas. The analysis of the IR for each of the study areas will be determined using absorbed dose, effective dose equivalent, and dose equivalent.

I. Absorbed Dose {D}

This is the energy absorbed per unit mass of the absorber. The traditional unit of absorbed dose is the rad, 1 rad = 100 ergs energy deposited in 1 gram = 0.01 joule energy/kg in any irradiated medium. The 'D' can be determined by multiplying the radiation dose rate (μ) with the exposure time (t), as shown in Equation 1.

$$D = \mu \, x \, t \tag{1}$$

II. Dose Equivalent {H_T}

The dose equivalent is used in radiation safety dosimeters to take into account differences in biological effectiveness among different radiations. Normalization factor (Q) is a multiplier of radiation dose (D) to give an equivalent dose. The H_T relationship is expressed as follows.

$$H = D \times Q \tag{2}$$

III. Effective Dose Equivalent {H_E}

The effective dose equivalent is employed for purposes related to radiation safety and regulatory compliance, taking into consideration the relative vulnerability of various organs and tissues to radiation-induced non-deterministic or stochastic effects, particularly in instances of non-uniform exposure (NCRP 1996). The effective dose equivalent (H_E) is determined by multiplying the dose received (H_T) by each irradiated tissue or organ by a specific weighting factor (W_T). Equation 3 present the mathematical framework for calculating the effective dose equivalent (H_E).

$$H_E = (W_T \times H_T) \tag{3}$$

TABLE 1 | Background radiation.

Sport viewing centers	Background radiation
Man-Tunkura	0.0122 mR/h
K. B.	0.0167 mR/h
T-Kurna	0.0160 mR/h

TABLE 2 | Radiation dose.

| Sport viewing centers	Radiation dose (μ_g)
Man-Tunkura	0.0230 mR/h
K. B.	0.0279 mR/h
T-Kurna	0.0275 mR/h

4 Results and discussions

Tables 1 and **2** present the background radiation and radiation dose from Man-Tunkura, K. B., and T-Kurna sport viewing centers. There is a close relationship between the background radiation and radiation dose of K. B. and T-Kurna viewing centers.

The annual absorbed radiation dose from the three selected sport viewing centers is presented in **Table 3** and depicted in **Figure 1**. Man-Tunkura has the lowest absorbed dose, followed by K. B. and T-Kurna with 0.5741, 0.6964, and 0.6864, respectively. All the radiation sources fall below the safety lower limit of ICRP.

Table 4 presents the radiation dose equivalent of the three (3) selected sport viewing centers. Man-Tunkura has the least dose equivalent of 0.0115, followed by K. B. with 0.0137

TABLE 3 | Annual absorbed radiation dose.

S/n	Radiation sources	Absorbed dose (mGy)
1.	Man-Tunkura	0.5741
2.	K. B.	0.6964
3.	T-Kurna	0.6864
4.	Safety lower limit	1.000
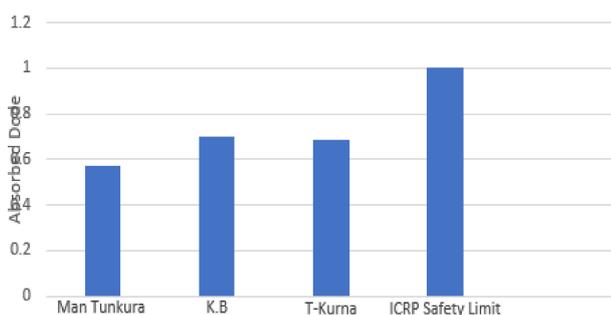
FIGURE 1 | Absorbed radiation dose measured.

TABLE 4 | Radiation Dose Equivalent.

| s/n	Radiation Sources	Dose Equivalent (Sv)
1.	Man-Tunkura	0.0115
2.	K. B	0.0137
3.	T-Kurna	0.0139
4.	Safety Lower Limit	0.0200
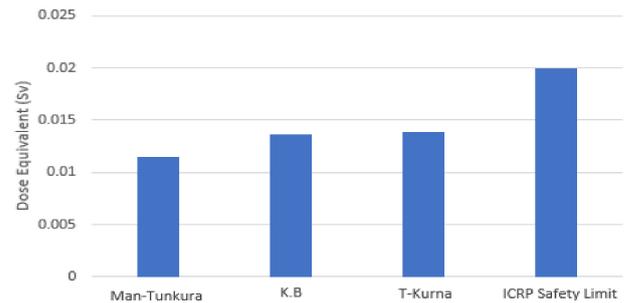
FIGURE 2 | Radiation dose equivalent measured.

and T-Kurna with 0.0139, respectively. All results are seen to fall far below the ICRP standard safety limit of radiation protection. The relationships of dose equivalent measured for the sport viewing centers are depicted in **Figure 2**.

From **Table 5** and as depicted in **Figure 3**, the effective dose equivalent at Man-Tunkura sport center has the lowest effective dose of 0.0237, followed by K. B. and T-Kurna sport centers. All the results of effective dose equivalent from the viewing centers fall far below the recommended safety limit of the ICRP safety limit of radiation protection. This implies that the viewing centers have no risk or significant health risk.

TABLE 5 | Effective radiation dose equivalent.

S/n	Radiation sources	Effective dose equivalent (Sv)
1.	Man-Tunkura	0.0237
2.	K. B.	0.0283
3.	T-Kurna	0.0287
4.	Safety lower limit	0.0500
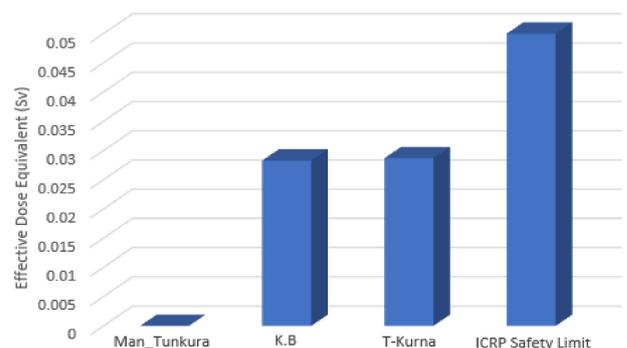
FIGURE 3 | Effective dose equivalent measured.

5 Conclusion and recommendation

Despite the fact that the use of television in homes and sport viewing centers has tremendously advanced in the field of technology, the health implications of radiation dose absorbed, dose equivalent, and effective dose equivalent have become an issue of concern for the people watching sports at the viewing centers due to overcrowding. Some are of the opinion that the radiation emitted from this television coupled with the overcrowding at the sport center, may have an effect to the people. An assessment of the radiation from the selected sport viewing centers were carried out. The results of absorbed dose, dose equivalent, and effective dose equivalent were determined. All the results fall far below the ICRP standard safety limit for radiation exposure. While the assessment suggests that ionizing radiation levels from electronic devices in viewing centers in Mubi are likely within safe limits based on comparable studies, implementing regular monitoring, safety protocols, and public education is crucial to ensure continued safety. Addressing the identified research gaps through targeted studies on device emissions, long-term exposure, and local environmental factors will provide a more comprehensive understanding of potential risks and inform evidence-based safety measures.

Author contributions

This work was carried out in collaboration between all authors. KG designed the study, carried out the analysis, and wrote the first draft of the manuscript. IY managed the literature searches, data acquisition, and proofread the manuscript before all authors approved the final manuscript.

Funding

We wish to declare that no funding is attached to the research work.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

1. ICRP. *International Commission on Radiological Protection Age-depended Dose to Members of the Public from Intake of Radionuclides. Part5: Compilation of Ingestion and Inhalation Coefficients. ICRP Publication 72*. Oxford: Pergamon Press (1996).

2. ICRP. The 2007 *Recommendations of the International Commission on Radiological Protection. ICRP Publication 103*. Vol. 37, Nos. 2–4. Canada: Annals of the ICRP (2007).

3. World Health Organization (WHO). *Ionizing Radiation and Health Effects*. Fact sheet (2023). Available online at: https://www.who.int/news-room/fact-sheets/detail/ionizing-radiation-and-health-effects

4. Chiegwu HU, Onyeka JO, Ugwuanyi DC, Odunk DD, Ogolodom MP, Mbaba AN, et al. Assessment of background ionizing radiation exposure levels in industrial buildings in Nnewi, Anambra State, Nigeria. *Int J Res Med Sci.* (2022) 10:305–15. doi: 10.18203/2320-6012.ijrms20220273

5. Meindinyo ROK, Ogobiri G, Ezekiel A. Radiation emission levels from monitor screens of some residential and office electronic equipments within a university community in Nigeria. *IOSR J Appl Phys.* (2017) 9:43–6.

6. Smith T, Jones L. Health implications of low-level radiation from CRT displays. *Occup Health Rev.* (2018) 33:45–52.

7. Anekwe UL, Munonye KO. Determination of human exposure to background ionizing radiation in federal medical centre Yenagoa, Bayelsa State, Nigeria. *Adv J Sci Eng Technol.* (2025) 10:33–44.

8. Anekwe UL, Uzoekwe SA. Evaluation of annual effective dose equivalent from environmental gamma radiation at sand mine valley in Yenagoa, Nigeria. *Int J Basic Sci Technol.* (2019) 5:65–74.

9. Jibiri NN, Isinkaye MO, Momoh HA. Assessment of radiation exposure levels at Alaba e-waste dumpsite in comparison with municipal waste dumpsites in southwest Nigeria. *J Radiation Res Appl Sci.* (2014) 7:536–41.

10. Eddy NO, Eze IS, Rajni G, Akpomie K, Udoekpote G, Timothy CL. Exploration of health effects, economic impacts, and regulatory challenges for ionizing radiation: a case study in Nigeria. *SN Appl Sci.* (2025) 7:575. doi: 10.1007/s42452-025-07069-z

11. Dambele MY, Wada Abdullahi M, Mohammed A, Ahmad Umar F, Baba SA, Emmanuel RI, et al. Assessment of radiation protection status of the radiology departments of two selected secondary hospitals in Kano Metropolis, Kano State, Nigeria. *J Radiogr Radiation Sci.* (2024) 38:35–41.

12. Sidi M, England A, Mansur U, Muhammad ZI, Garba I, Zira DJ, et al. Radiation protection measures of the radiological facilities in Kano metropolis, Nigeria. *West African J Radiol.* (2022) 29:118–24. doi: 10.4103/wajr.wajr_4_22

13. Eze K, Okoye O. Assessment of radiation exposure from electronic devices in public viewing areas. *J Radiation Protection Africa.* (2018) 5:67–75.

14. Adebayo O, Okunola A, Eze K. Radiation exposure from consumer electronics in public spaces. *J Environ Health.* (2020) 45:123–30.