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# Assessment of Background Ionizing Radiation Levels in Selected Markets in Ile-Ife and Modakeke: A Public Health Perspective

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**Abstract:** This study assessed background ionizing radiation (BIR) levels in six markets across Ile-Ife and Modakeke, Southwestern Nigeria, to evaluate potential health risks. Annual effective dose rates (AEDR) were measured and analyzed using a handheld Geiger Counter. Results showed AEDR values ranging from 0.67 mSv/y at Texaco Market to 2.52 mSv/y at Sabo Market. The average AEDR across all markets was below the global population average exposure of 2–3 mSv/y. The findings suggest that BIR exposure in these markets is primarily due to naturally occurring radionuclides in the soil and rocks, with no significant anthropogenic contributions. This study concludes that the BIR levels in these markets pose no significant health risks to users.

**Keywords:** Annual effective dose rate, Dose equivalent, Market environment, Radiation exposure

## I. Introduction

The environment is constantly inundated by background ionizing radiation from a host of sources [1]–[7]. Most background ionizing radiation stems naturally from radioactive materials within the earth's crust, water bodies, and the atmosphere [8]–[11]. Cosmic radiation from outer space also contributes to the natural background ionizing radiation in the environment. A small fraction of background ionizing radiation is from anthropogenic sources (medical radiation facilities, nuclear fallouts, consumer products, nuclear power plants, building materials, and the like). Background ionizing radiation levels may vary from place to place and from time to time over any given location.

The ubiquitous nature of background ionizing radiation ensures that humans and other life forms are constantly exposed to ionizing radiation. Human exposure to background ionizing radiation is often elevated, mostly, by a host of human activities that are capable of releasing or introducing radionuclides contaminants into the environment [12]. The amount of background ionizing radiation that an individual is exposed to from time to time depends on various factors which include; geographical location, altitude, occupation, and lifestyle [13]–[15].

Although radiation is beneficial in many ways, it still has harmful effects on humans and other forms of life [16]. Exposure to high levels of radiation is therefore a public health concern. While acute exposure to high levels of ionizing radiation can be harmful to human health, the low levels of background radiation that we are typically exposed to in our daily lives may not be considered to be of any significant health risk. However, chronic exposure to even low levels of background ionizing radiation can still pose significant health risks to the public [17]. Because of the harmful effects of ionizing radiation, the practice has been to monitor and assess the levels of exposure with the view of keeping the public exposure to ionizing radiation as low as reasonably achievable. To this end, the International Commission on Radiation Protection (ICRP), and the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) routinely set and review worldwide exposure limits for the protection of humans and wildlife [17]–[19]. A host of human activities redistribute the radionuclides concentration in the environment, thereby elevating the level of background ionizing radiation in the environment. Additionally, some anthropogenic activities have been known to deplete the ozone layer as a result, increasing the amount of cosmic radiation reaching the earth.

The current research aims to assess background ionizing radiation dose rate levels in selected consumer markets in Ile-Ife and Modakeke, two neighboring communities. The goal is to determine potential health impacts on market goers from these radiation levels. These markets primarily deal with agricultural products, where buyers and sellers frequently interact. It is important to evaluate whether the background ionizing radiation levels are elevated enough to pose health concerns for individuals who visit these markets regularly, sometimes daily. The market shops are mostly open-sided structures designed to protect traders from the elements. In some cases, traders display their goods directly on the ground and use umbrellas for shade.

## II. Materials and Methods

### Location of the Study Area

The study covers some selected consumer markets in Ile-Ife and Modakeke, Osun State, Southwestern part of Nigeria (Figure 1). Ile-Ife and Modakeke are neighbouring communities located approximately between latitudes $7.48^0$ N and $7.50^0$ N, and longitudes 4.530 E and $4.56^0$ E [20]. The two communities have a combined population of approximately 1 million inhabitants.

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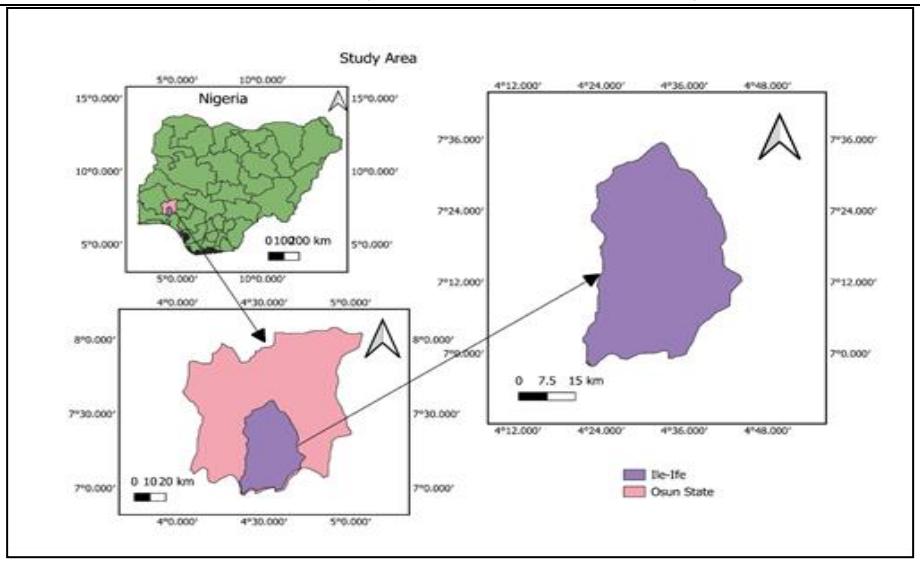


Figure 1. Study area showing the location of Ile-Ife and Modakeke (Drawn using QGIS version 3.34.3)

**Sampling and Measurement**

Background radiation dose rate levels in the selected markets were measured using a handheld FNIRSI GC-01 Geiger Counter Nuclear Radiation Detector. The device is capable of detecting x-rays, γ-rays, and ß-rays. With this device, doses can be measured in µSv/h, µGy/h, mR/h, counts per second (cps), and counts per minute (cpm). It has a gamma energy range of 48 keV-1.5 MeV and a sensitivity of 80 cpm.

In this current work, average dose rates (AVDR) in air were measured *in-situ*, in µSv/h. At every sampling point, average dose rate levels were obtained over a five-minute period. Every sampling point was geo-located using a Global Position System (GPS). The data obtained for the external dose rate levels (in µSv/h) in air were converted into annual effective dose rates (AEDR) to the whole body (in mSv/y) using the relation [21], [22]:

$$AEDR(\mathrm{mSvy^{-1}}) = 24 \times 365\ (h/y)\ \ \mathrm{AVDR(mSv/h)} \qquad (2)$$

The data was therefore presented in terms of AEDR (mSv/y) (Figure 2).

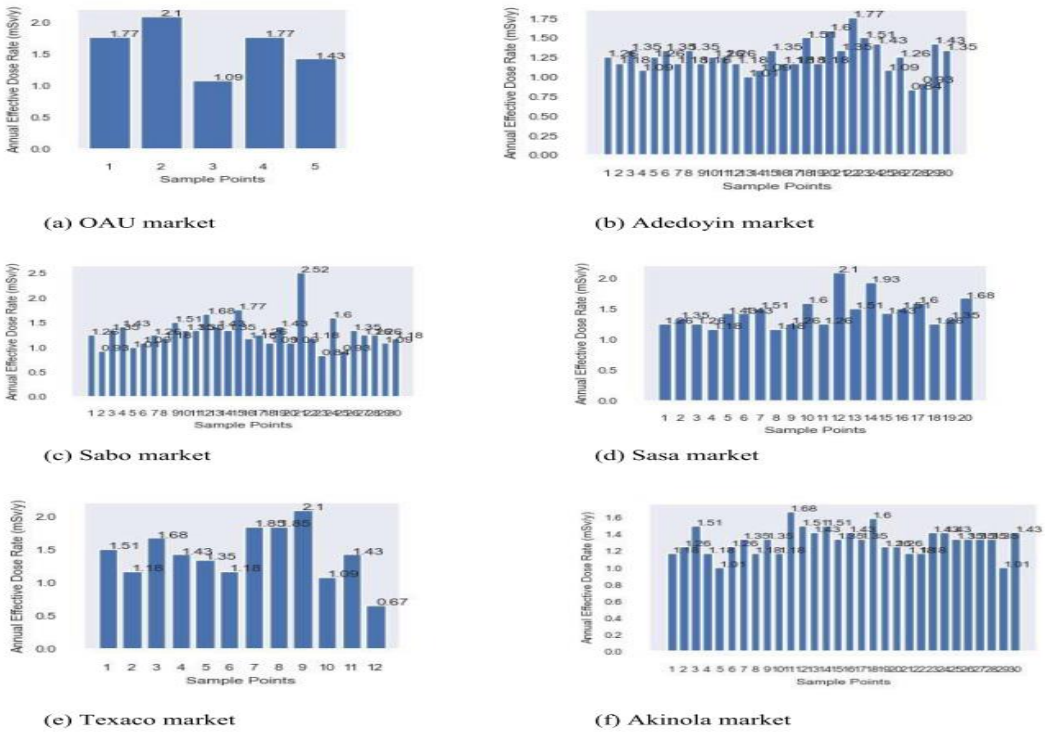


Figure 2. Annual effective dose rates at the respective markets

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Table 1. Comparison of AEDR in this study with other studies

| Location | AEDR (mSv/y) | Reference |
|---|---|---|
| **OAU Market** | 1.63 | Present study |
| **Adedoyin Market** | 1.26 | Present study |
| **Sabo Market** | 1.31 | Present study |
| **Sasa Market** | 1.41 | Present study |
| **Texaco Market** | 1.44 | Present study |
| **Akinola Market** | 1.33 | Present study |
| **Emelagu village, Rivers State** | 0.48 | [13] |
| **Ikot Akpaden Campus, Akwa Ibom State** | 0.244 | [23] |
| **Quarry site in Ebonyi State** | 0.27 | [24] |
| **Keffi dumpsites, Nasarawa State** | 0.19 | [25] |
| **Itu, South-South, Nigeria** | 6.83 | [26] |
| **Farin Gada, Plateau State** | 1.54 | [27] |
| **Fadawa, Plateau State** | 2.18 | [27] |
| **Odus, Plateau State** | 3.22 | [27] |
| **Jib village, Plateau State** | 1.61 | [27] |
| **Jacopiang, Plateau State** | 1.58 | [27] |
| **Building materials, Plateau State** | 1.72 | [27] |
| **Nnewi, Anambra State** | 0.23 | [28] |
| **Ijebu-Ife, Ogun State** | 0.182 | [29] |

## III. Results and Discussions

### Annual effective dose rates (AEDR)

The annual effective dose rates recorded at the six markets investigated are shown in Figure 2a to 2f.

***OAU market (Figure 2a):*** The maximum AEDR of 2.1 ± 0.384 mSv/y was recorded at latitude $7.51552^0$ N and longitude $4.51278^0$ E, while the minimum AEDR of 1.09 ± 0.384 mSv/y was recorded at latitude $7.51838^0$ N and longitude $4.50992^0$ E. The average annual effective dose rate at this market was 1.632 ± 0.384 mSv/y.

***Adedoyin market (Figure 2b)*:** The maximum and minimum annual effective dose rates at this market were 1.77 ± 0.193 mSv/y and 0.84 ± 0.193 mSv/y, respectively, recorded at latitude $7.47356^0$ N, longitude $4.539^0$ E, and latitude $7.47377^0$ N, longitude $4.53925^0$ E, respectively, with an average of 1.265 ± 0.193 mSv/y.

***Sabo market (Figure 2c):*** The maximum AEDR was 2.52 ± 0.314 mSv/y obtained at latitude $7.48895^0$ N, longitude $4.55352^0$ E, and the minimum AEDR was 1.307 ± 0.314 mSv/y was, at latitude $7.48829^0$ N, longitude $4.55348^0$ E, with an average of 1.307 ± 0.314 mSv/y.

***Sasa market (Figure 2d):*** The maximum AEDR of 2.10 ± 0.241 mSv/y ($7.45328^0$ N and $4.55647^0$ E), with the minimum AEDR of 1.18 ± 0.241 mSv/y ($7.45306^0$ N, $4.55687^0$ E and $7.45312^0$ N, $4.55677^0$ E), while the average was 1.454 ± 0.241 mSv/y.

*Texaco market (Figure 2e):* The maximum value of AEDR was 2.10 ± 0.392 mSv/y at latitude $7.4886^0$ N, longitude $4.53316^0$ E, and the minimum was 0.67 ± 0.392 mSv/y at latitude $7.48839^0$ N, longitude $4.53389^0$ E. The average AEDR at this market was 1.443 ± 0.392 mSv/y.

***Akinola market (Figure 2f):*** The maximum and minimum annual dose rates of 1.68 ± 0.155 mSv/y and 1.01 ± 0.155 mSv/y, respectively. The maximum was found at latitude $7.49882^0$ N, longitude $4.44151^0$ E, while the minimum was found at two locations ($7.49898^0$ N, $4.44151^0$ E, and $7.49772^0$ N, $4.44159^0$ E). The average annual at this market was 1.330 ± 0.155 mSv/y.

Overall, the annual effective dose rates range from 0.67 mSv/y to 2.52 mSv/y, with the highest and lowest values found at Sabo market (Fig 2c) and Texaco market (Fig 2e), respectively. Furthermore, the averages of the AEDR at all six markets (Fig 3) are

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lower than the worldwide population average values of about 2 to 3 mSv/y [18]. Table 1 indicates that the mean annual effective dose rates from background ionizing radiation measured in this study across the six markets are consistent with values reported in similar studies conducted in various regions of the country. Further still, it shows that the radiation levels in these markets are not elevated, suggesting that the exposure to ionizing radiation in the selected markets is primarily due only to the trace amounts of radionuclides found in the soil and rocks within the market.

## IV. Conclusion

The study investigated the annual effective dose rates (AEDR) in six markets, revealing that values ranged from 0.67 mSv/y to 2.52 mSv/y, with the highest and lowest values observed at Sabo Market and Texaco Market, respectively. Average AEDR values in all markets were below the worldwide average population exposure levels of 2–3 mSv/y, suggesting that radiation levels in the studied markets are within safe limits. The findings indicate that exposure to ionizing radiation in these markets is primarily attributed to trace radionuclides naturally present in the soil and rocks. The results align with similar studies conducted in other parts of the country, suggesting that the markets do not exhibit elevated radiation levels. These observations imply that the environmental radiation exposure in the studied areas poses no significant health risk to the population.

## Declarations

### Conflict of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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### Data access statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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