



## Radiological Health Implications of Indoor Gamma Radiation Exposure in Akoko Area, Ondo State, Southwestern Nigeria.

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### Abstract

#### Keywords:

Gamma dose rate,  
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Akoko area,  
Annual effective dose,  
Excess lifetime cancer risk.

*Exposure to gamma radiation is in varying quantity among the living creatures. Exposure due to gamma radiation inside homes and offices are indoor gamma radiation. In this study, a high performance Handheld Inspector 1000 Digital Multichannel Analyzer was used to measure indoor gamma dose rate in 19 communities in Akoko area of Ondo state, Nigeria. A total of 716 measurement points were covered in the area. Indoor gamma dose rate ranges between 0.03 to 0.25  $\mu\text{Svh}^{-1}$  with a mean value of  $0.103 \pm 0.02 \mu\text{Svh}^{-1}$ . The indoor annual effective dose varied between 0.484 to 1.009 mSvy<sup>-1</sup> with a mean value of 0.723 mSvy<sup>-1</sup>. The excess cancer risk varied between  $1.6923 \times 10^{-3}$  to  $3.532 \times 10^{-3}$  with an average value of  $2.529 \times 10^{-3}$ . The values of the measured radiological parameters obtained in this research were observed to be within the recommended limit of 1 mSvy<sup>-1</sup> dose limit for the general public. Therefore, the area is free from any health hazard due to radiation, and therefore, can be described as radiologically safe.*

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### INTRODUCTION

Exposure to gamma radiation occurs everywhere on the Earth surface. Gamma decay from naturally occurring radioisotopes and secondary radiation from atmospheric interactions with cosmic ray particles are the major natural sources of gamma radiations on Earth. Everything on the Earth surface including the plants, human body and vegetation, are being exposed to one form of radiation or the other (Unsear, 2000). Human beings are being exposed to various degrees of gamma radiation depending on the geographical and geological factors of their location and their ventilation habit. The largest radiation source in the environment is from the natural background. The worldwide annual effective dose is 2.4 mSvy<sup>-1</sup> with a wide range of individual doses. Medical radiation takes the second largest

contribution to radiation exposure with annual effective dose estimated to be 0.4 mSv. In addition, human activities involving the use of radiation and radioactive substances enhance radiation burden of the environment in addition to those from natural sources. Environmental contamination with radioactive residues from nuclear weapons testing continues to be a global source of human radiation exposure (Unsear, 2000).

The indoor exposure to gamma radiation depends on radionuclides concentrations in outdoor air, the radionuclides concentrations in underlying rock and soil and the building materials used for construction purposes and the gamma radiation releases from the decay products of radon-222. The indoor exposure to

gamma rays mainly determined by the materials of construction is greater than outdoor exposure if Earth materials have been used because the radionuclides present in the building materials used added up to the outdoor gamma radiation absorbed by the building and the indoor area is less ventilated compared to outdoor environment (Unsear, 2000b).

Gamma radiation is ionizing, the external exposure above the International Commission on Radiological Protection (ICRP) recommendation of  $1 \text{ mSv} \cdot \text{y}^{-1}$  dose limit for the general public (ICRP, 1991) can produce various deleterious effects on human health. Ionizing radiation has enough energy to destabilize the atoms in living cells. This can cause damage to the (genetic material) deoxyribonucleic acid (DNA) of the cell. The cells in our bodies can efficiently repair this damage correctly. However, if the damage is not repaired correctly, the cell may die or eventually become cancerous (IAEA, 2004). Radiation doses absorbed at different rates by different parts of the body can cause different health hazard. Deterministic effect of radiation such as skin erythema, sterility, cataracts and fibrosis occur only if the dose or dose rate is greater than some threshold value (Goptal, 2001). The effect which occurs within a limited time is more severe as the dose and dose rate increases. Stochastic effects of radiation involves lower doses delivered over a long period of time. It may give no early signs of injury, but the tissues may be damaged in such a way that the effects appear in later generations of the exposed person. These effects are not certain to occur but the probability of occurrence increases as the dose increases (IAEA, 2004). Such effects includes radiation induced hereditary effects and cancer incidences (Goptal, 2001). For low doses of radiation, the relationship between cancer risk and dose is linear, that is, as the dose increases the risk increases and any radiation dose has a detrimental

## STUDY AREA

This research was carried out in Akoko area of Ondo State. The study covers 19 communities in the four Local Government Areas (LGAs) of Akoko. The communities are Ikare in Akoko North East (AKNE) LGA, Arigidi, Ajowa, Ikaram, Ogbagi, Oke-Agbe, and Irun in Akoko North West (AKNW) LGA, Oke-Oka, Supare, Iwaro-Oka, Akungba, Oba, Etioro, Ayegunle, and Ikun in Akoko South West (AKSW) LGA, Epinmi, Isua, Ifira, and Ipesi in Akoko South East (AKSE) LGA. Akoko area in Ondo state is located in the Northern Senatorial District of Ondo state, Southwestern Nigeria. It lies between longitude  $5^{\circ}30'$  and  $6^{\circ}30'$  of Greenwich meridian and latitude  $7^{\circ}20'$  and  $7^{\circ}45'$  north of the equator. Akoko area is made up of undulating lowlands with isolated hills and lies within the transition zone of the tropical equatorial climate of Southern Nigeria and tropical continental climate of Northern Nigeria. The total amount of rainfall is about 1200 mm and mean temperature of about  $21^{\circ}\text{C}$ . The annual temperature range is about  $3^{\circ}\text{C}$  and mean relative humidity is about 80 %. The study area is situated in the basement complex of Southwestern Nigeria, generally referred to as migmatite gneiss quartzite complex (Rahaman, 1976). In some part of the area, there are quarry industries as the area is endowed with igneous rock such as the granite gneiss. This type of rock had been identified to contain high level of radionuclides (Unsear, 2000b). Figure 1 Present the geological map of Ondo State showing the study area by LGA headquarters. Oke-Agbe, the headquarter of AKNW LGA, Ikare, the headquarter of AKNE LGA, Isua, the headquarter of AKSE LGA, and Oka, the headquarter of AKSW LGA. The map showing the different communities is presented in Figure 2.

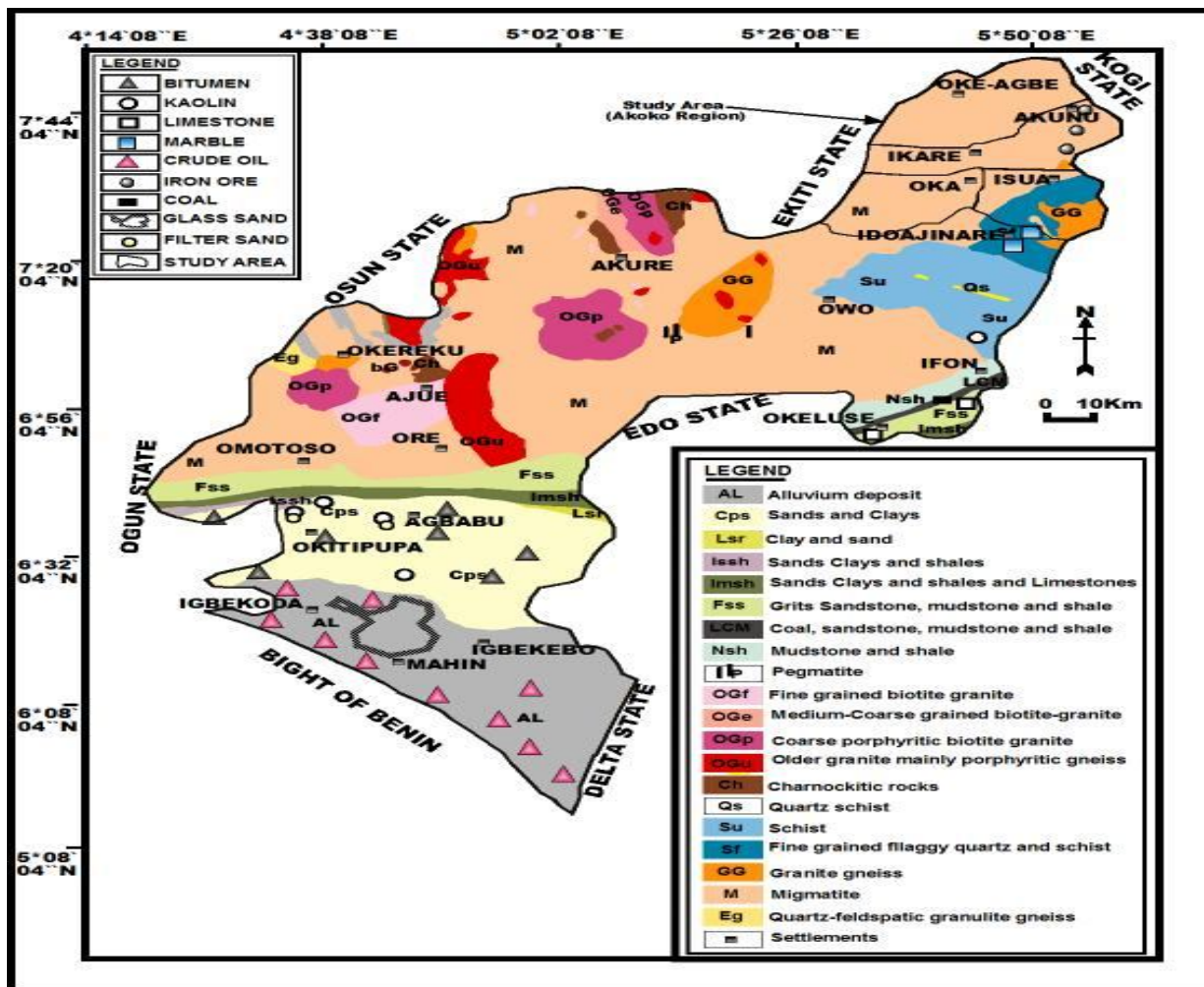


Fig 1. Geological map of Ondo State showing the study area

## MATERIALS AND METHOD

The gamma dose rate direct measurements were performed with a portable Inspector 1000 Digital Handheld Multichannel Analyzer. It is a Sodium Iodide Scintillation detector with a serial number 13000399, manufactured and well calibrated by the Canberra Industries. It has an energy range of 50 KeV to 3 MeV. The detector was placed at a customized height of one meter above the ground with the probe facing downward to take the measurement. Measurements time interval was 6 minutes (IAEA-TECDOC, 2003). The indoor measurements was taken inside homes and workplaces such as schools, offices, shops, hospitals and cafeteria (Clouvas, 2004). Three readings were taken consecutively in a location and the average recorded to represent the value for the location. A fixed distance measurement of 1 meter was used to enable uniform measurement distance interval. About

716 measurements points were covered in this research.

## RESULTS AND DISCUSSIONS

### Gamma Dose Rate

Gamma dose rate measured in the 19 communities ranges between 0.03 to 0.25  $\mu\text{Svh}^{-1}$ . The mean gamma dose rate value for the area varied between 0.069 to 0.144  $\mu\text{Svh}^{-1}$  with an average value of  $0.103 \pm 0.02 \mu\text{Svh}^{-1}$ . The lowest gamma dose mean value of  $0.069 \mu\text{Svh}^{-1}$  was obtained in Ikaram Akoko while the highest mean value of  $0.144 \mu\text{Svh}^{-1}$  was obtained in Epinmi -Akoko. The indoor gamma dose radiation map for the area is presented in Figure 2. The map showed the study area and the mean gamma dose rate value obtained in each town where measurements were taken. Such map had been presented in previous researches (Clouvas et al., 2004, Asere and Ajayi, 2017).

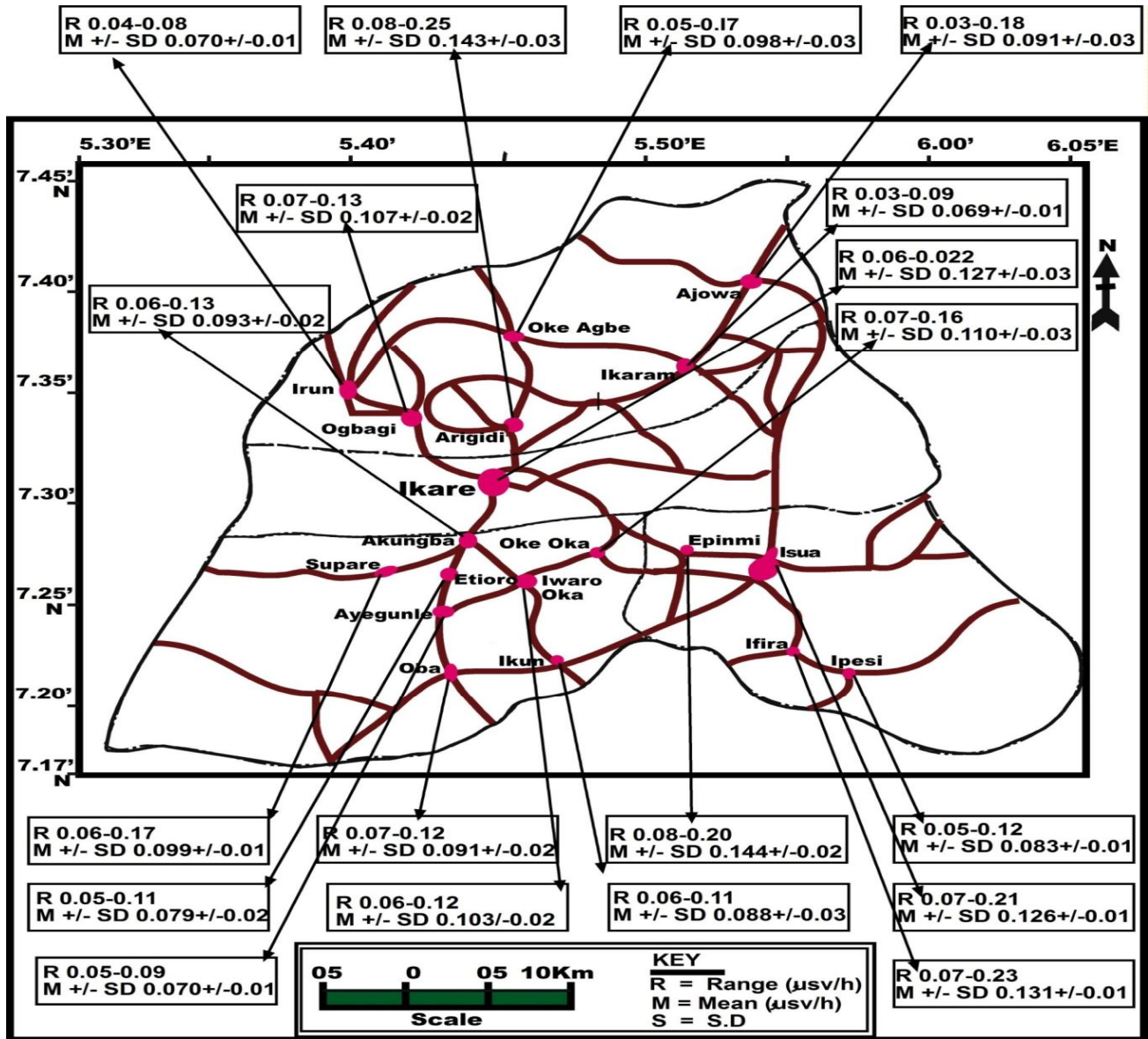


Fig 2. Indoor Gamma Dose Rate Radiation Map of Akoko Area.

**Annual Effective Dose**

The instrument used in this research measures dose rate equivalent on the depth 10 mm of human tissue (Svh<sup>-1</sup>). The annual effective dose, He (mSvy<sup>-1</sup>) was calculated using

$$He = D * T * F \text{ -----(1)}$$

Where D (nSvh<sup>-1</sup>) is the mean dose rate value for each town, T is the time of the year (8760 hy<sup>-1</sup>) and F is the indoor occupancy factor (0.8) (Unsclear, 2000b). The annual effective dose in the area varied between 0.484 mSvy<sup>-1</sup> to 1.009 mSvy<sup>-1</sup> with a mean value of 0.723 mSvy<sup>-1</sup>. This value is less than the 1 mSvy<sup>-1</sup> recommended for the member of the public. Figure 3 presents the variation of annual dose in each town.

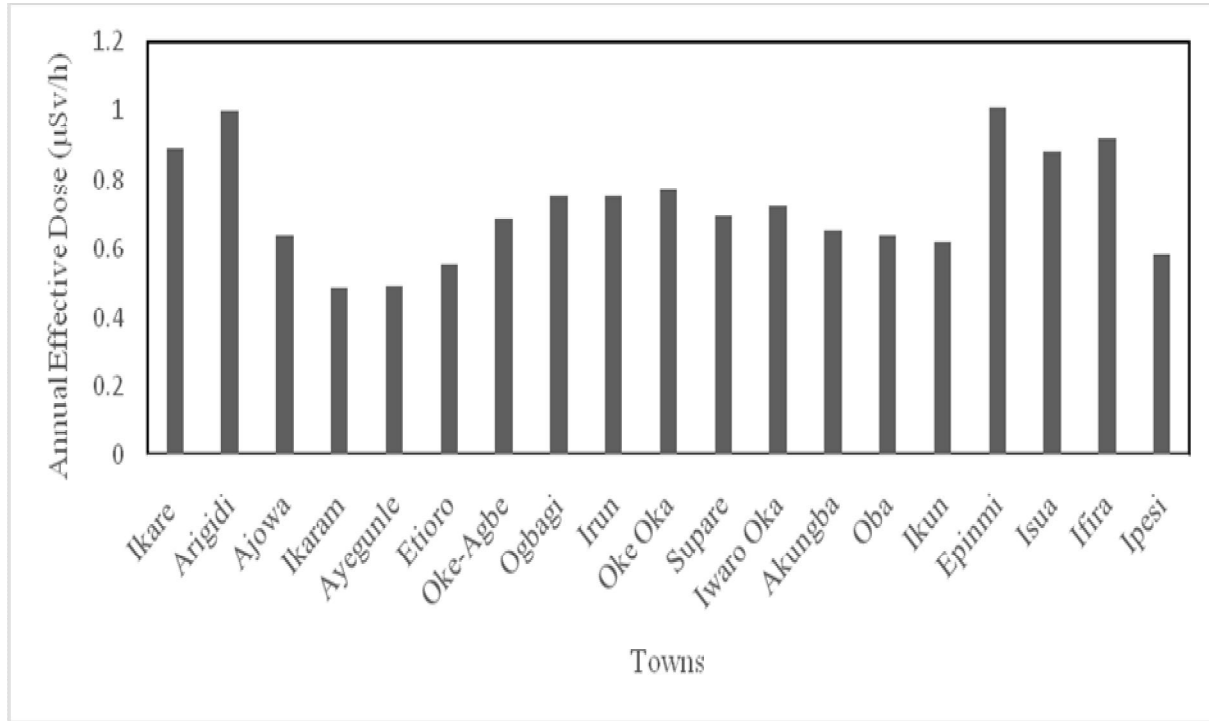


Fig 3. Indoor Annual Effective Dose in Akoko area

**Excess Lifetime Cancer Risk**

The Excess Lifetime Cancer Risk was calculated using

$$ELCR = He * DL * RF \text{-----(2)}$$

(Ononugbo et al., 2015) Where DL is duration of life, taken to be 70 years continuous exposure to gamma radiation. He is the calculated values of annual effective dose (mSv<sup>-1</sup>). RF is the risk factor or fatal cancer per Sievert. For low dose background radiation which are considered to produce stochastic effects, ICRP 60 uses a value of 5x10<sup>-2</sup> Sv<sup>-1</sup> for the public exposure. The Excess Lifetime cancer risk ranges from 1.692x10<sup>-3</sup> to 3.532x10<sup>-3</sup> with an average value of 2.529x10<sup>-3</sup>.

**CONCLUSIONS**

This research was carried out to determine the radiological health effect of continuous exposure to gamma radiation indoors in 19 communities in Akoko area of Ondo State, Nigeria. The annual effective dose mean value of 0.723 mSv<sup>-1</sup> received in Akoko area was lower than the recommended 1mSv<sup>-1</sup> for the members of the public. Therefore, the occupants of these areas are relatively safe but future radiological contamination of the environment should be avoided. This study serves as a baseline with which to compare future measurements.

The highest indoor annual effective dose of 1.009 mSv<sup>-1</sup> was recorded in Epinmi Akoko town in AKSE LGA. This is in the same range with the recommended 1mSv<sup>-1</sup> dose limit for the members of the public. Ifira Akoko in AKSE LGA, likewise, had the highest outdoor annual effective dose of 0.210 mSv<sup>-1</sup>(Asere and Ajayi, 2017). Oladele et al., (2018), indicated that AKSE LGA had the highest average annual effective dose in Ondo State. The geological feature of the LGA is responsible for this. Akoko South East LGA is one of the LGAs that is endowed with igneous rocks such as granite that may contain higher concentration of natural radionuclides

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