EVALUATION OF INDOOR AND OUTDOOR BACKGROUND IONIZING RADIATION OF SELECTED RESIDENTIAL BUILDINGS IN IBARAPA CENTRAL, OYO STATE, NIGERIA

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Abstract
Indoor and Outdoor Ionizing radiation exposure levels were measured using a total of 10 randomly selected dwelling categorized as local and modern buildings in Ibarapa Central Local Government of Oyo State. All radiations were taken at the sample point for Indoor and Outdoor measurements by holding the survey meter at 1m above ground surface or floor to prevent unwanted effects of radiation from the soil or building floor. The detector was held at five meters away from the buildings nearby in order to avoid unwanted effect of the buildings materials on Outdoor measurements. Each measurement was repeated six times and the average was taken to represent the value for a sample point. The indoor exposure dose rate (0.27μSvh^{-1}) is higher in local building than in modern building (0.23 μSvh^{-1}) while the outdoor exposure dose rate (0.25 μSvh^{-1}) is higher in modern building than in local building (0.23 μSvh^{-1}). The result of all the location sampled revealed low exposure dose rate when compared with the average exposure dose rate (2.4mSvy^{-1} or 0.27 μSvh^{-1}) according to international commission in Radiological protection (ICRP, 1990). It Can be concluded that there was no harmful ionizing radiation from the selected residential buildings in Ibarapa Central Local Government of Oyo State, Nigeria. It is recommended that regular and periodic monitoring of the background ionizing radiation level should be carried out to assess the health risks of the denizens of that area.

Keyword: *Indoor radiation, residential building, outdoor radiation, ionizing radiation.*

Introduction

Radiative materials occur naturally on the environment and emit radiation but some are also produced artificially. Artificial radiations had led to dramatic advances in medical diagnosis and treatment. It is also used for a wide range of procedures in industry, agriculture and research. Nevertheless, they can be harmful to human beings and care must be taken to prevent unnecessary or excessive exposure. Some of the harmful effect, includes: cancer, cataract, gene mutation, destruction of bones and blood cell and can resulted into the death of an individual (Jwanbot, 2011). These ionizing radiations come from three main sources namely: cosmic radiation, terrestrial and radioactivity radiation into human body. It is the spontaneous decay of the nuclei of heavy isotopes that leads to emission of radiation body (Ike, 2003).

Terrestrial background ionizing radiations are essentially derived from 40K, and radionuclides belonging to 238U and 232Th series present in the earth crust (Karunakara *et al.*, 2014, UNSCEAR 2000). These radionuclides are common in the rocks, soil, water, plants and air that make up the planet and in building materials (Gupta et al., 2010, UNSCEAR, 2000). The variation of terrestrial radiation is typically larger than that of cosmic radiation (Karunakara *et al.*, 2014). The health impact of exposure to radon (222Rn), inhalation by humans in the indoor and outdoor environment is a major public concern worldwide. The exposure is due to emanation of radon gas from the decay chains of radioactive thorium (232Th) and uranium (238U), which are present in soil layers (Mohammed *et al*., 2014) and indoor construction materials especially granite (Kabeissi *et al*., 2013).

Some of the materials used in the construction of buildings are known to be radioactive (Hayumbu *et al.,* 1995). The dose rate depends on the geology geographical conditions and appears at different levels in the soil of each region of the world (Abusini *et al.,* 2007; Mitiullah et al., 2004; Ali *et al*., 2014). Higher radiation levels are associated with igneous rocks such as granite and lower levels with sedimentary rocks. However some shale and phosphate rock have relatively high content of those radionuclides (Tzortzis & Tsertos, 2004). Soil is an important environmental material used for making bricks and building raw materials. Previous works showed that dwelling with mud wall registered high value of radon than dwellings with brick and Portland cement (Arif *et al*., 2014; Ashok et al., 2012; Sathish *et al.,* 2009; Sivakuma, 2010; Rakesh *et al*., 2006).

Studies (indoor and outdoor) on natural radioactivity have been conducted in many countries of the world because the knowledge of natural radioactivity is very important to accurately assess possible radiological risk to human health and establish local controls where necessary (Saghatchi, Salou, & Eslami, 2008). As part of the contribution to the global data on natural radioactivity from Nigeria, this study was carried out to assess the indoor and outdoor background ionizing radiation across residential buildings in Ibarapa Central Local Government, Oyo State, Nigeria. Although, previous reports from studies on background radiation in some States of Nigeria have been carried out such as: (Ajayi, 2009; Ajayi, Ibikunle, & Ojo, 2008). But data from Ibarapa Central Local Government of Oyo State on environmental radioactivity is quite scanty. And there is therefore a need to carry out a compressive study of the natural radioactivity in the state. The result from this study will be geared towards estimating annual effective dose of the residents in the study area and form part of the baseline data for future use.

Materials and Methods

The indoor and outdoor radiation surveys were carried out using gamma survey meter. The RDS-30 Radiation Survey Meter is a versatile gamma radiation detector, designed for a wide range of applications involving the possibility for abnormal radiation levels. Its measurement ranges is between 1 μR/hr to 10 R/hr with operating conditions of 25^{o}C to +55^{o}C and displays in μSv/h. It is compact, lightweight and waterproof. Its performance and user friendly interface make the RDS-30 suited to radiation survey in field conditions as in nuclear industry or for protection against radiological hazards

The residential buildings used for this study were categorized into two groups: local building (buildings with bare floor, wood/no ceiling, just roof, no fan, made with mud/clay bricks) and modern building (buildings with tiled floors, marble wall, plaster of Paris, PVC ceiling or aluminum roofing sheet). A total of 20 residential buildings (10 local and 10 modern) were purposively selected across the study area from which 5 local and 5 modern buildings were randomly sampled for the study. The background radiation were measured both indoor and outdoor of the selected buildings. Measurements at each location were performed by holding the survey meter at 1 m above the ground surface and from the wall to avoid unwanted effects of radiation from soil or building materials. Each of the outdoor measurement was taken at least five meter from the walls of nearby building and repeated six times and the average was taken to represent the value for the location.

RESULTS

Table 1: Indoor and Outdoor Background Radiation on Local Building

Sample /Location	Mean Indoor (μSvh^{-1})	Mean Outdoor (μSvh^{-1})
1	0.27	0.21
2	0.24	0.20
3	0.26	0.23
4	0.25	0.22
5	0.24	0.21
$\frac{Efx}{Ef}$	0.25	0.22

Source: Researchers' fieldwork

Table 2: Indoor and Outdoor Background Radiation on Modern Building

Sample /Location	Mean Indoor (μSvh^{-1})	Mean Outdoor (μSvh^{-1})
1	0.20	0.19
2	0.22	0.16
3	0.21	0.22
4	0.23	0.20
5	0.22	0.25
$\frac{Efx}{Ef}$	0.22	0.20

Source: Researchers' fieldwork

Table 3: Comparison of The Mean Indoor & Outdoor Background Radiation for Local and Modern Building Standard Average Does Value.

Categories of Building	Average indoor (μSvh^{-1})	Average outdoor (μSvh^{-1})	Standard value (μSvh^{-1})
Local Building (LB)	0.25	0.22	0.27
Modern Building (MB)	0.22	0.20	0.27

Source: Researchers' fieldwork

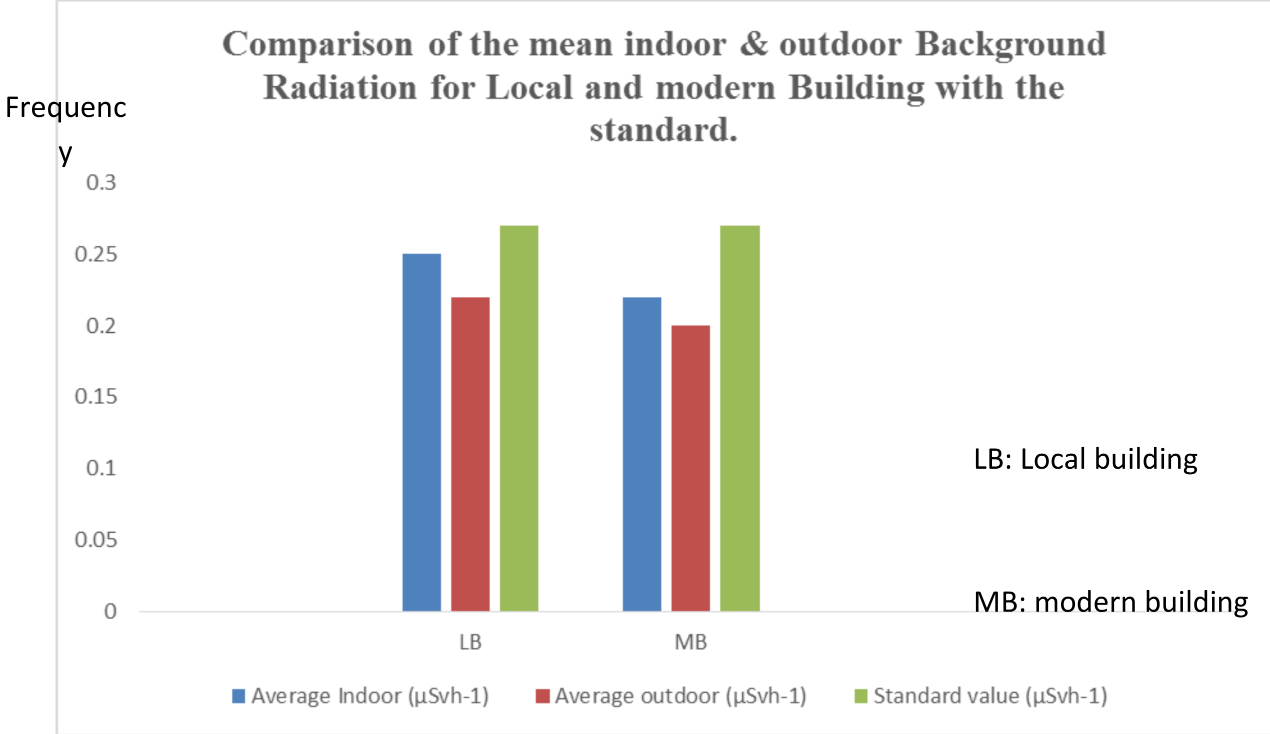

Figure 1: Comparison of the mean indoor & outdoor Background Radiation for Local and modern Building with the standard average does value.

Results and Discussion.

From the study, background indoor and outdoor ionizing radiation exposure level were determined for two categories of buildings (Local and Modern) in Ibarapa Central Local Government of Oyo State, Nigeria. As revealed in Tables 1 and 2, the mean indoor exposure does rate (0.27µSvh^{-1}) is higher in local buildings than in modern buildings (0.23µSvh^{-1}), while the mean outdoor exposure does rate (0.25µSvh^{-1}) is higher in modern buildings than in local buildings (0.23µSvh^{-1}). More so, the slight differences in the distribution of the indoor dose rates might have resulted from the contribution of the building materials of which the building were made and the geology of the study area. In addition, the local buildings had the highest contribution to the total indoor doses rates, this might have resulted from the fact that the local buildings are characterized with bare floors and walls of the buildings were built with mud or clay bricks. The clay and the mud were the major building materials for local buildings and these may contain higher radionuclides than those of the modern materials {tiles, asbestos and concrete floor} for modern buildings. Therefore, it is very important that the radiological contents of the building materials from the study areas especially the local building materials (mainly mud/clay) be extensively assessed.

However, from Figure 1, results of all the location sampled with the mean indoor and outdoor dose rate between 0.22 µSvh^{-1} and 0.27 µSvh^{-} indicated low exposure dose rate when compared with the average exposure dose rate (2.4 mSvy^{-1} or 0.27 µSvh^{-1}) according to International Commission on Radiological Protection (ICRP, 1990). The doses observed in indoor is in line with the findings of Oladele *et al.*, 2018 who had confirmed that the indoor dose was higher in both local and modern buildings. The findings of this research disagrees with that of Negi *et al.*, 2009 who found out that outdoor dose rate was higher than indoor in rural houses. It is therefore concluded that there was no harmful ionizing radiation from the selected residential buildings in Ibarapa Central Local Government of Oyo State, Nigeria. It is recommended that regular and periodic monitoring of the background ionizing radiation level should be carried out to assess the health risks of the denizens of that area.

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