



Measurement of Indoor Radon Concentration of Some Selected Residential Houses in Lapai Town, Niger State, Nigeria

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ABSTRACT

Twenty (20) residential houses in Lapai town were selected for indoor radon measurements. Rad7 was setup in sniff mode and purged outdoor for about 10 minutes to clear the sample chamber of radon gas and daughters before each measurement. Each location was measured for 3 hours with an hourly result saved. The indoor radon concentration (CRn) ranged between 2.53 ± 0.20 Bq m⁻³ and 20.4 ± 2.20 Bq m⁻³ with a mean value of 9.65 ± 1.02 Bq m⁻³. The corresponding annual effective dose (Daf) varied from 0.06 ± 0.01 mSv y⁻¹ to 0.51 ± 0.06 mSv y⁻¹ with a mean of 0.24 ± 0.03 mSv y⁻¹. All the indoor radon concentrations measured were less than the 100 Bqm⁻³ action level proposed by World Health Organization (WHO). The mean Daf value was lower than the 1.0 mSv y⁻¹ precautionary limit for the public set by International Commission on Radiological Protection (ICRP). Though the result shows no immediate health effect, it is important to sensitize the public on the ways to reduce indoor radon to mitigate against long time exposure effect.

Keywords: Radon gas, Lapai, Residential houses

INTRODUCTION

Radon (²²²Rn) is produced from the ²³⁸U decay series (from ²²⁶Ra), it is a noble and radioactive gas with half-life of 3.82 days decays into a series of solid and short-lived radioisotopes. It disintegrates into polonium (²¹⁸Po), bismuth (²¹⁴Bi), lead (²¹⁴Pb) and polonium (²¹⁴Po) (Belete & Anteneh, 2021). Radon emanates from rock, soil and building materials, such as concrete, cement and paint, and diffuses into buildings through the floor, holes and cracks in the walls (WHO, 2023). The amount of radon present in buildings or indoor air is affected by some factors which include: weather condition, building materials, height above the ground, the composition of soil around the building, ventilation, and the use of the room (Abdelrahman, 2001). Most of the domestic radiation exposure, especially affecting the respiratory tract, is due to radon and its daughters that are coming from the building materials and the soil beneath the building (Fucic, 2012). Due to changes in the concentration of ²²⁶Ra existing in the soil, the level of radon and its daughters change considerably with time (Vogiannis and Nikolopoulos, 2015).

Radon, its isotopes and their progeny contribute fifty two percent (52 %) of the total annual effective dose to the general public from natural radiation sources (UNSCEAR, 2008).

Investigations have shown that continuous exposure to radon gas and its daughters (polonium, bismuth and lead) causes lung cancer and other radiation induced sicknesses such as Alzheimer and Parkinson disease (UNSCEAR, 2000; Ajrouche *et al.*, 2018; Gaskin *et al.*, 2018). The naturally occurring radon found in buildings has been determined to be a human lung carcinogen, making radioactive radon gas the second-leading cause of lung cancer in people, right after tobacco usage (Cousins *et al.*, 2011). Some studies have shown that even low levels of radon, such as those typically found in household settings; can be harmful to health and increase the risk of lung cancer globally (WHO, 2023).

This work measured the radon concentration of some selected residential houses in Lapai town which will serve as reference point data as well as inform the populace on the health risks associated with the radon.

METHODOLOGY

Indoor radon measurements of twenty (20) selected residential houses in Lapai town were carried out using Rad7 electronic radon monitor (Figure 1) manufactured by DURRIDGE Company, USA. RAD7 was setup in sniff mode

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which allows air containing only radon gas to be drawn automatically from the environment into RAD7 chamber through the inlet filter. The monitor was purged outdoor for about 10 minutes to clear the sample chamber of radon gas and daughters before each measurement. Each location was measured for 3 hours with an hourly result saved. The results were viewed afterwards, analysed and mean radon concentration within the period of measurement of office was computed using CAPTURE software.

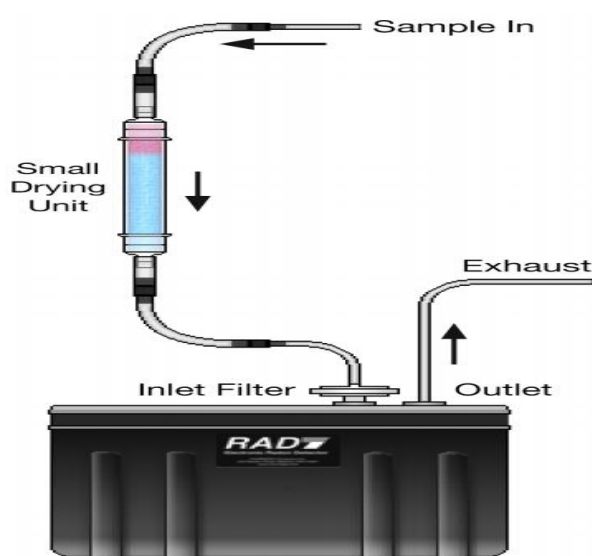


Figure 1 RAD7 radon monitor setup

The indoor radon concentrations measured in each location of the study were used to estimate the annual effective doses. The annual effective dose (D_{af}) was calculated using equation 1 (ICRP, 2009);

$$D_{af}(mSvy^{-1}) = E_f \times C_f \times O_f \times CR_n \times T \quad 1$$

Where E_f is the equilibrium factor (0.4), C_f is the effective dose conversion factor (9.0×10^{-6} mSvh⁻¹ per Bq/m³), O_f is the Occupancy factor (0.8), CR_n is the radon concentration (Bq/m³) and T (time) is hours in a year (24 hours x 365 days).

RESULTS AND

Table 1: Measured indoor radon concentrations (CR_n) and computed annual effective doses (D_{af}) of the house.

Table 1 show the indoor radon concentration (CR_n) measured from twenty (20) houses (modern and old houses) and the corresponding

annual effective dose (D_{af}). The modern houses are made with blocks and the rooms have two windows (cross ventilation) whereas the old houses were made with mud with the rooms having only one window. From Table 1, the indoor radon concentration ranged between 2.53 ± 0.20 Bq m⁻³ and 20.4 ± 2.20 Bq m⁻³ with a mean value of 9.65 ± 1.02 Bq m⁻³. The lowest indoor radon concentration value was found in H2 and H11 while the highest indoor radon concentration value was found in H18. The high value of indoor radon concentration in H18 may be due to crack on the ground as a result of the age of the building. All the indoor radon concentrations measured were less than the 100 Bqm⁻³ action level proposed by World Health Organization (WHO, 2009). The reason for low abundance of indoor radon concentration in the investigated houses could be depending on building materials, sufficient ventilation, the nature of soil in the region and the lifestyle of the individual living in this building.

The corresponding annual effective dose varied from 0.06 ± 0.01 mSv y⁻¹ to 0.51 ± 0.06 mSv y⁻¹ with a mean of 0.24 ± 0.03 mSv y⁻¹. The mean D_{af} value was lower than the 1.0 mSv y⁻¹ precautionary limit set for the public (ICRP, 1991).

The result of this work is lower than that of Bashir *et al.*; (2023) which measured the indoor radon in some offices within Ibrahim Badamasi Babangida (IBB) University Lapai. The reason for low abundance of radon in the investigated rooms could be due to difference in building materials and sufficient ventilation as sufficient ventilation reduces the concentration of the indoor radon concentrations because of the air circulation. This study revealed that proper ventilation in a building reduces the level of radon that will be recorded in a particular building; the more the ventilation the lower the radon level.

Table 1: Measured indoor radon concentrations (CRn) and computed annual effective doses (D_{af}) of the house.

Location Code	Location characteristics	CRn (Bqm ⁻³)	D_{af} (mSv yr ⁻¹)
H1	Modern house	10.10 ± 1.10	0.25 ± 0.03
H2	Modern house	2.53 ± 0.20	0.06 ± 0.01
H3	Modern house	5.06 ± 0.50	0.13 ± 0.01
H4	Modern house	15.3 ± 1.68	0.39 ± 0.04
H5	Modern house	2.55 ± 0.20	0.06 ± 0.01
H6	Modern house	10.02 ± 1.02	0.25 ± 0.03
H7	Modern house	15.2 ± 1.67	0.38 ± 0.04
H8	Modern house	15.3 ± 1.68	0.39 ± 0.04
H9	Modern house	2.55 ± 0.20	0.06 ± 0.01
H10	Modern house	12.7 ± 1.39	0.32 ± 0.04
H11	Old house	2.53 ± 0.20	0.06 ± 0.01
H12	Old house	5.10 ± 0.51	0.13 ± 0.01
H13	Old house	2.53 ± 0.20	0.06 ± 0.01
H14	Old house	10.2 ± 1.10	0.26 ± 0.03
H15	Old house	17.7 ± 1.94	0.45 ± 0.05
H16	Old house	12.7 ± 1.39	0.32 ± 0.04
H17	Old house	15.2 ± 1.67	0.38 ± 0.04
H18	Old house	20.4 ± 2.20	0.51 ± 0.06
H19	Old house	2.55 ± 0.22	0.06 ± 0.01
H20	Old house	12.7 ± 1.39	0.32 ± 0.04
Minimum		2.53 ± 0.20	0.06 ± 0.01
Maximum		20.4 ± 2.20	0.51 ± 0.06
Mean		9.65 ± 1.02	0.24 ± 0.03

Conclusion

The indoor radon concentrations of twenty (20) residential houses were measured using Rad7 radon monitor. The mean indoor radon concentration (CRn) and corresponding annual effective dose (D_{af}) were 9.65 ± 1.02 Bq m⁻³ and 0.24 ± 0.03 mSv y⁻¹ in sequence. The mean CRn is below the 100 Bqm⁻³ action level proposed by World Health Organization and the D_{af} is also below the recommended safety limit of 1.0 mSv y⁻¹ set for the public by International Commission on Radiological Protection.

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