Nigerian Journal of Physics (NJP)
ISSN online: 3027-0936
ISSN print: 1595-0611
DOI: https://doi.org/10.62292/njp.v33i2.2024.221
Volume 33(2), June 2024

Radiological Assessment of Background Radiation and it's Associated Risk in Junior Secondary School Idu-Koro Abuja, Nigeria

***Ojo, E. O., Abdulahi, H. A., Adelowo, A. A., Tine, A. A., Dauda, A. K., Shittu, H. O., Aliyu, A. and Egga, A. A.**

Science Infrastructure Directorate, National Agency for Science and Engineering Infrastructure NASENI, Abuja, Nigeria.

*Corresponding author's email: ojo.emmanuel@naseni.gov.ng

ABSTRACT

The primary cause of natural background radiation exposure in the general public has been radon and its shortlived decay products in homes, which account for around 50% of the population's effective dose worldwide. Radon (^{222}Rn) and its progeny inside building and environments have been recognized as a global issue and a substantial risk factor for lung cancer. In this research,Inspector alert nuclear radiation meter (manufactured by S.E international U.S.A SN:35440) with inbuilt Geiger-Muller tube was employed to determine the concentration of ^{222}Rn in the eleven (11) investigated points at Junior Secondary School Idu-Koro Abuja, to calculate the tenants' effective dose from ^{222}Rn and its progeny. The meter was held at the abdominal level (about 1 m above the ground surface). The dosimetric measurements were taken in count per minute (cpm) mode and the radon concentration range from $54.0 \pm 8.0\, cpm$ to $80.7 \pm 5.3\, cpm$. Conversion was made from count rate to dose rate, absorb dose rate, annual dose rate and finally effective dose rate for comparison. The effective dose to the occupants was estimated ranging from $0.108\, mSv/yr$ to $0.163\, mSv/yr$, with a mean of $0.129\, mSv/yr$. The radon contents were establish to be lesser than the reference value from the international commission for radiological protection (ICRP) as the appropriate safety; hence it may not result to any health effect of lung cancer to the occupants and the members of public within the investigated areas.

Keywords:
Radiation,
Radon,
Dose parameters,
Nuclear radiation monitor.

INTRODUCTION

Exposure to ionizing radiation from natural sources is an ongoing and inevitable aspect of existence. Every day, humans are subjected to natural background radiation originating from various sources such as the earth, building materials, air, food, outer space, and even substances within their own bodies. Primordial radionuclides and their offspring generate gamma radiation, which is a significant external source of radiation exposure for humans (Saleh *et al*., 2013). Natural surroundings radiation contributes approximately 81% of the annual dose to the population and artificial background radiation contributes the remaining 19%' (Damaris, 2014). Natural and man-made radiations do not differ in kind or effect, man-made radiation is generated in range of medical, commercial and industrial activities. The most familiar and in national terms, the largest of these sources of exposure is medical X-rays (Damaris, 2014). The Earth's crust contains small amounts of naturally radioactive materials such as uranium and thorium. Uranium and thorium decay to other radioactive atoms, including radium, which then decays to radon gas. Since radon is an inert (that is, chemically stable) gas, it moves from the soil, where it is produced, and into the air. Radon is a natural part of the earth's atmosphere. The amount of uranium and radium in soil varies greatly with geographic location and soil type. Therefore, the amount of radon gas released to the atmosphere also varies across the United States (Damaris, 2014).

Residual radium formed during activities have the prospective to cause work-related exposure to radon, along with it short-lived progeny. The chemical element radon has two radiologically important isotopes that occur in nature: radon-220 and radon-222. Subsequent accepted usage, this element refers to formerly as "thoron" and the latter on as "radon". Radon and its short-lived progeny (decay products) are continuously produced by decay of radium-226, a member of the naturally occurring uranium-238 series. Airborne concentrations of radon's short-lived progeny (polonium-218, lead-214, bismuth-214, and polonium-214) are of interest due to their potential for deposition in the lung, leading to subsequent irradiation of lung tissue by alpha emissions from polonium-218 and polonium-214 (Strom*et al*., 1996). Studies of miners in uranium and other underground mines have shown that high exposures to the short-lived progeny of radon significantly increase the risk of acute leucopoenia, anemia and necrosis of the mouth, cataract, chronic lung cancer and leukemia (Avwiri et al., 2016; Sureshgandi *et al*., 2014). In 1990 radon study revealed an average indoor radon concentration of 0.91 pCi/L, and identified 86 buildings at 26 different sites with radon levels at or above 3.6 pCi/L (DOE 1990) in USA. In a 1992 report for compliance with National Emission Standards for Hazardous Air Pollutants, twelve were identified with elevated radon levels (Strom et al., 1996).

In the oil and gas industries, naturally occurring radium and its daughter products can build up as scale in pipes and vessels. The de-scaling of these results in occupational radiation exposure and in waste streams containing radium. In the smelting of iron ore, high concentrations of lead-210 and polonium-210 occur in dusts and residues. In other metal smelting applications, the use of special mineral sands containing natural uranium and thorium can lead to exposures either directly or from the enhanced concentrations in foundry slag (Avwiri *et al.*, 2016). The study of the distribution of these radionuclide helps in the determination of the radiological health implication of exposure to gamma rays and inhalation of radon and its daughter products at the Junior Secondary School, Idu-Koro Community in Abuja Municipal Area Council (AMAC) as seen in figure 1.

The aim of this study is to measure the concentration of natural background radiation level and absorb dose rate by students, staff and the members of general public of Junior Secondary SchoolIdu-Koro Abuja, Nigeria. The values obtained from the study will serve as baseline data for environmental radiation in the study area.

The important of this study is to contribute to the development of radiation protection standards. From the data obtained, radiological health parameters were estimated from the activity concentration of these background radiation in order to assess health implication of exposure of general public to the studied area, the study area is situated near the industrial area where the activities is taking place but there is no radiological data on natural radioactivity level of the area. The result of this study will serve as the natural background radiation database for this area since there has not been any radiological study of the area.

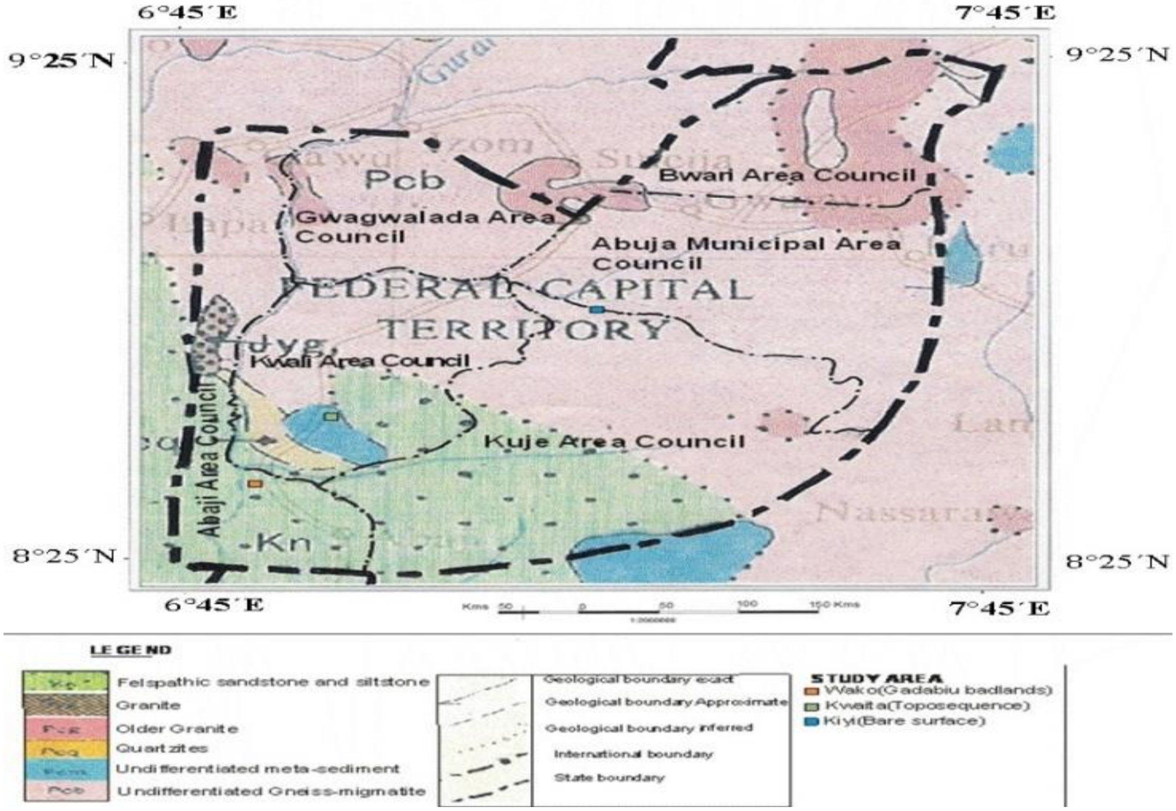

Figure 1: Study location map (Nimat Omowumi Abdulazeez *et al., 2017*)

MATERIALS AND METHODS

This study was conducted in October, 2018. The count dose rate measurement of Junior Secondary School Idu-Koro Abuja, Nigeria was carried out using well calibrated inspector alert nuclear radiation monitor with inbuilt Geiger-Muller tube. The Geiger -Muller counters were placed with the end window facing the area where count rates were taken as recommended by the manufacturers of the Geiger-muller counters, and at a height of one meter above the ground (Ebong *et al*., 1992; Okoye *et al*., 2013). Measurements were carried out in camp per minutes (CPM) from eleven points. The geographical location (Coordinate point) in each measurement was recorded using GPS (geographical positioning system) to give spatial coverage. The readings were taken three times with each and an average taken and recorded. The values were then converted to Sv using the relation: 1 CPM= 0.01 µSv/hr (Radalert-100 User's Manual, 2007).

The average exposure rates were computed, together with their corresponding standard deviation, as presented in the table below, utilizing the given equation:

$$Count\ dose\ rate\ (CPM) = \frac{\sum N}{n} \qquad (1)$$

Where $\sum N$ is the sum of all the readings taken from the field under investigation N is the frequency. The dose rate was calculated through the relationship given below;

$$D.R = C.D.R \times 10^{-2} \mu Sv/hr \qquad (2)$$

Where $C.D.R$ is the count dose rate.

The absorb dose rate

$$(A.D.R) = D.R\ (\mu Sv/hr) \times 10^{3}\ nGy/hr \quad (3)$$

Where $D.R$ is the dose rate.

The annual dose rate was evaluated using relation;

$$A.D.R = D.R \times 10^{-3} mSv/yr \times 6hrs \times 5\ days \times 4\ weeks \times 12\ months \qquad (4)$$

However, the effective dose rate (mSv/yr) was calculated using the relation below;

$$E.D.R = A.D.R\ (nGy/hr) \times 1440hy/yr \times o.f \times c.c10^{-6} \qquad (5)$$

occupancy factor of 0.2 as well as conversion coefficient of $0.7Sv/Gy$ was used to calculate , and the results are presented in the table below.

RESULTS AND DISCUSSION

Results

The measured and calculated quantities which include count dose rate (CPM), dose rate $(\mu Sv/yr)$, Absorb dose rate (nGy/hr), Annual dose rate (mSv/yr) and the effective dose rate (mSv/yr) from background radiation in different pints as well as precise locations of measurements are shown in Table 1. The geographical locations of the regions are also showed in Figure 1.

Table 1: Mean ADR, EDR and Excess Lifetime Cancer Risk (ELCR)

Data Code	Count Dose Rate (CPM)	Dose Rate (µSv/hr)	EDR ($mSv\,yr^{-1}$)	**ELCR(10^{-3})**
A	75.3	0.75	1.65	5.77
B	54.0	0.54	1.18	4.14
C	72.7	0.73	1.59	5.57
D	72.7	0.73	1.59	5.57
E	80.0	0.80	1.75	6.13
F	61.3	0.61	1.34	4.70
G	67.7	0.68	1.48	5.19
H	80.7	0.81	1.77	6.19
I	80.7	0.81	1.77	6.19
J	62.7	0.63	1.37	4.81
K	69.3	0.69	1.52	5.31
Mean	**70.6**	**0.71**	**1.55**	**5.41**
UNSCEAR	**100**	**1.00**	**2.40**	**2.90**

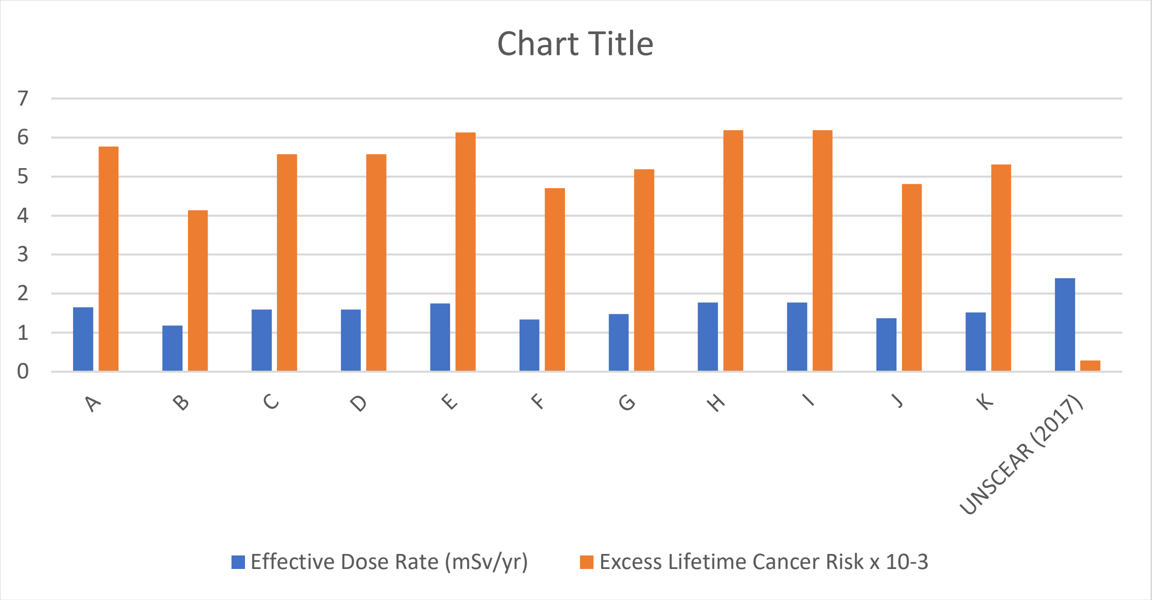

Figure 2: Mean ADR, EDR and Excess Lifetime Cancer Risk (ELCR)

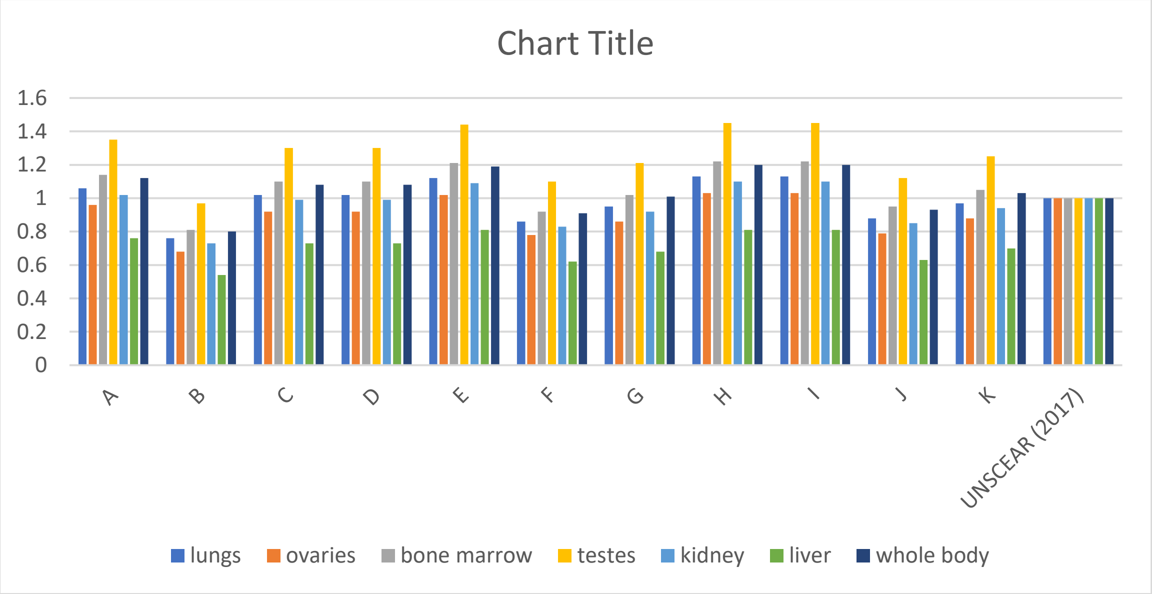

Figure 3: Effective Dose to Different Sensitive Organs of the Body

Discussion

In this study, the obtained dose values were due to effective dose of external environmental background radiation. It is clear that by taking into account the effective dose due to internal radiation, the combined annual effective dose will be lower than the current values. According to UNSCEAR (2000) report, radon and its progeny are responsible for half of the total annual effective dose of natural background radiation and it was shown that the mean effective dose resulting from ^{222}Rnwas estimated to be 0.129 mSv/yr. By considering the results of this study and other studies, some differences, both in location and dose values were observed (Sohrabi & Esmaili 2002). In our study the radon concentration range from $54.0 \pm 8.0\, cpm$ to $80.7 \pm 5.3\, cpm$. Conversion was made from count rate to dose rate, absorb dose rate, annual dose rate and finally effective dose rate for comparison. The effective dose to the occupants was estimated ranging from $0.108\, mSv/yr$ to $0.163\, mSv/yr$, with a mean of $0.129\, mSv/yr$. The radon concentrations were found to be lower than the reference value from the international commission for radiological protection (ICRP) as the appropriate safety; hence it may not result to any health effect of lung cancer to the occupants and the members of public within the investigated area. According to the

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) report (2000), the worldwide average annual exposure to natural radiation sources is 2.4 mSv.

CONCLUSION

From this study, it revealed that the annual effective dose is in the range from $0.108\ mSv/yr$ to $0.163\ mSv/yr$, which is lower than the recommended value given by ICRP. Since the radon and its progeny areprinciple components to annual effective doses, periodic studies for evaluation of their role in internal radiation in these areas are essential. It seems that the observed differences between the results of this study and other studies are due to the dynamic nature of such areas. Studies on the long-term effects of high level natural background radiation are also necessary.

REFERENCES

Abdulazeez, N. O., Ojo, E. O. and Shittu, H. O., *(2017)*: Assessment of Radiological Hazards Accompanied with Naturally Occurring Radioactive Materials (NORM) at Selected Boreholes in the FCT, Abuja, American Journal of Environmental and Occupational Health, Vol. 3, No. 2, 2017, pp. 10-15. http://www.aiscience.org/journal/phpm

Ebong, I. D. U and Alagoa, K. D., (1992). Fertilizer impact on ionization Radiation Background at a production plant, Nigerian Journal of Physics, Vol.4 143-149

Ghazwa, A., Fauziah, B., Hamid, S. and AbdulRahman, I., (2016). Assessment of Natural Radioactivity Levels and Radiation Hazards in Agricultural and Virgin Soil in the State of Kedah, North of Malaysia. The Scientific World Journal Volume 2016, Article ID 6178103, 9 pages http://dx.doi.org/10.1155/2016/6178103.

Karam, P. A., (2002). The High Background Radiation Area In Ramsar Iran: Geology, Norm, Biology, Lnt, And Possible Regulatory Fun. WM ’02 Conference, February 24-28, 2002, Tucson, AZ.

Muneer, A. S., Ahmad, T. R., Yasser, A., Abubakar, S. A., (2013). Assessment of Natural Radiation Levels And Associated Dose Rates From Surface Soils In Pontian District, Johor, Malaysia. Journal of Ovonic Research Vol. 9, No. 1, p. 17 – 27.

Okoye, P. C. and Avwiri, G. O., (2013). Evaluation of background ionizing radiation levels of Braithwaite memorial specialist hospital Port Harcourt, River State. American Journal of Scientific and Industrial Research. ISSN: 2153-649X, doi: 10.5251/ajsir.2013.4 (4):359-365.

Olubosede, O., Akinnagbe, O. B. and Adekoya, O., (2012). Assessment of Radiation Emission from Waste Dumpsites in Lagos State of Nigeria. International Journal Of Computational Engineering Research, Vol.2, Issue No. 3, 806-811, ISSN: 2250–3005.

Ononugbo, C. P. Avwiri, G.O. and Tutumeni, G. (2016). Measurement Of Natural Radioactivity And Evaluation Of Radiation Hazards In Soil Of Abua/Odual Districts Using Multivariate Statistical Approach. British Journal of Environmental Sciences Vol.4, No.1, pp.35-48.

Osiga-Aibangbee, D., (2014). Radiation Level Measurement In Delta State University, Campus III, Abraka, Nigeria. Sci-Afric Journal of Scientific Issues, Research and Essays.Vol. 2 (11), Pp. 503-517.

Sohrabi, M., Esmaili, A. R., (2002). New public dose assessment of elevated natural radiation areas of Ramsar (Iran) for epidemiological studies. International Congress Series 1225. 2002:15– 24.

Strom, D. J., Reif, R. H., Andrews, D. A., George, A. C., George, J. L., James, A. C., Jones, C. R., Langner, Jr. G. H., Gavrilas-Guinn, M., Neton, J. W., Rabovsky, J. L., Runkle, G. E., Carlson, D. S., Dudney, C. S., Gammage, R. B., Maisler, J. A., Rose, S., Wilson, D. L., (1996). Occupational Exposure to Radon and Thoron, Radiological Control Coordinating Committee, U.S. Department of Energy.

Suresh, G. M., Ravisankar, R., Rajalakshmi, A., Sivakumar, S. Chandrasekekaran, A. and Pream, A. D. (2014). Measurement of natural gamma radiation in beach sediments of north east of Tamilnadu India by gamma ray spectrometry with multivariate statistical approach. Journal of Radiation Research and Applied Sciences 7: 7-17.

Tayyeb, A. P., Hamed, B. and Maryam, S., (2012). Evaluation of High Level Environmental Background Radiation Areas and its Variation in Ramsar. Iranian Journal of Medical Physics, Vol. 9, No. 2, Spring 2012, 87-92.

UNSCEAR., Sources and Effects of Ionizing Radiation. United Nations Scientific Committee on the Effects of Atomic Radiation, Report to the General Assembly, with Scientific Annexes. United nations publication sales No. E.00.IX.3., United Nations, New York, 2000.