ISSN 2286-4822
www.euacademic.org

EUROPEAN ACADEMIC RESEARCH
Vol. X, Issue 10/ January 2023

Impact Factor: 3.4546 (UIF)
DRJI Value: 5.9 (B+)

Estimation of the contribution of Radon-222 levels to risk of lung cancer in homes Atbara city, Sudan

SAMIA MOHAMMED ALSAID
MOHAMMED HASHIM ALBASHIR[1]
HASHIM GAD ELSEED
HAJHAMED DIAB ALJALY
ZAHRA MOHAMMED
Department of Physics, Nile Valley University, Sudan

Abstract

This study aims at measuring Radon Gas concentration in residential areas in Atbara Locality River Nile state, and estimate the annual effective dose and excess life-time cancer risk to the residents were measured, The Radon Gas concentration is measured by using Radon Scout Device, which measures gas concentration through reagents technology that using semi-conductors, because of its characteristic of high sensitivity . The device had been used in closed rooms for three indoor successive hours, measuring Radon Gas concentration. The study includes 150 houses in different areas in Atbara locality, all the houses were in Atbara town residential area which consists of 27 residential areas. Radon concentration in Atbara locality ranged between (70-3)Bg\\$m^3$ and the average concentration of Radon Gas was21.06 Bg\\$m^3$. The annual mean effective dose of 222Rn in Atbara is (0.509) mS/y. the estimated excess, lifetime cancer risk was 9×10^{-4}. The mean concentration of 222Rn indoor air relative to WHO and EPA standards are 21.0% and **14.0** *%,the concentration of 222Rn indoor air of all homes is less than the WHO guideline and EPA standard limits The study shows that Radon Gas in Atbara Locality is relatively low compared to Levels of intervention adopted by the International organizations for Environment protection.*

Keywords: Radon-222, Lung cancer, Effective dose, Radiation, Atbara

1- INTRODUCTION

Radon is a noble gas that is colourless and odorless. All its known isotopes are unstable. Radon-222 is a result of the intermediate decay of uranium-238, thorium-233 which are the primary sources of indoor radon found in soil, rocks, drinking water, building materials, and natural gas [1, 2]. Radon-222 has half-life of 3.82 days. Allowing it to travel through soil and into the air before decomposing into a series of short-lived radioactive offspring via particle emission. Two of them, polonium-218 and polonium-214, decay by emitting particles. Radon is normally ejected quickly after ingestion. Its solid, short-lived progeny tend to be deposited on the bronchial epithelium, exposing cells to irradiation The majority of human radon exposure occurs in the home [3, 4]. The amount of radon that enters the residence varies based on the geology of the area[2].

---

[1] Corresponding author: m.albashir8888@gmail.com

Home exposure to short-lived radioactive breakdown products of the chemically inert gas radon-222 accounts for around 50% of all non-medical ionizing radiation exposure in various countries[1]. Radon pollution of the air is common. Concentrations are low outside, but can build up indoors, particularly in homes, where the bulk of the population is exposed. Employees underground, notably in uranium mines, have consistently been exposed to the greatest levels. In studies of miners exposed to radon, it has been related to lung cancer[5]. Residential radon, which entails less exposure in a substantially larger number of people, may cause a significant minority of all lung cancers in many countries, according to extrapolation from these studies. This is significant in reality because radon concentrations in existing buildings may typically be reduced at a cheap cost (for example, by boosting underfloor ventilation),

The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) reported in 2000 that radon-222 contributes 1.0 mSv to the 2.4 mSv average yearly effective dose from natural radioactive sources. Although radon has less of an influence on human health when exposed to it outside, its accumulation in enclosed locations such as residences, mines, and workplaces might offer an additional health concern [6]. Long-term exposure to high amounts of indoor radon contributes to functional respiratory consequences and raises the risk of lung cancer [7]. Long-term radon inhalation in enclosed rooms is responsible for approximately 3-20% of all lung cancer fatalities [8]. Important research in Europe, North America, India, and China confirmed that radon exists.

Many European countries have conducted long-term studies to directly quantify the risk of lung cancer associated with residential radon exposure.

Radon concentrations are lower in urban regions than in rural areas since the underlying rock is mostly sedimentary and more people live upstairs in apartments. Furthermore, smoking is more widespread in cities. As a result, radon concentrations in homes are negatively associated with smoking[9].

2- MATERIAL AND METHODS

2.1 Area of study:

The study area of study located at 310 km from Khartoum city the capital of Sudan. Atbara is a city located in River Nile State in north-eastern Sudan.[1] Because of its links to the railway industry, Atbara is also known as the "Railway City'. As of 2007, its population is 111,399. The area locates at the geographic coordinates 33°77'88" E and 17° 70'6" N. (Figure 1) [2].

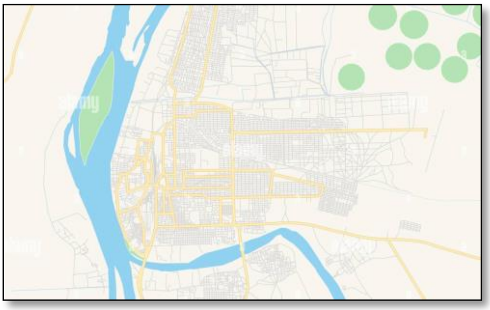

Figure -1: Atbara city map

2.2 Measuring the radon concentration:

222Rn air concentration was measured using portable device Radon Scout Plus meters device GmbH which made by SARAD company in Germany (Figure 2). The sensitivity of this device is 1.8 counts/ min× KBq/m3 (independent on the humidity) and response time 120 minutes to 95% of the final value [9]. High sensitivity with alpha spectrometry analysis, leads to a short response time even at low concentrations. According to the measuring instructions provided by SARAD company, for continuous measurement; more than 3hours; the device should be placed in slow mode to increase the accuracy [10-11], Measurement of 222Rn concentration was done in 150 homes carried out for 3 hours by home. In sum, the 150 measurements of 222Rn were done in indoor air of homes. 150 houses were in Atbara town residential area which consists of 27 residential areas.

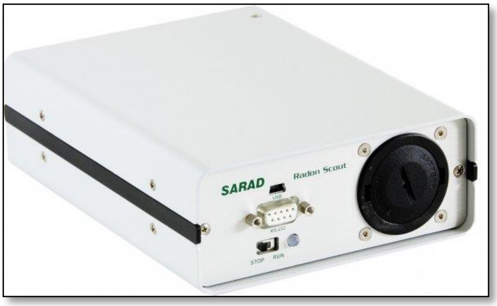

Figure- 2: Radon detector Radon Scout from SARAD GmbH

2.3 Determine the annual effective doses:

The average annual effective dose (mSv/y) of the residents of Tehran, caused by indoor radon concentration air, was determined using the following eq (1)[12].

$$E_{Rn}=C_{Rn}\times F\times H\times T\times D \qquad (1)$$

Where:
C is radon concentration (Bq.m^{-3}).
F is the equilibrium factor which is equal to 0.4 for measurement of indoor radon concentration.
H is occupancy factor which is 0.8 for measurement of indoor radon concentration.
T is duration of occupation for 1 year that is roughly equal to 8760 hrs.
Occupancy factor is equal to the amount of person's attendance per year in the desired location in terms of the number of hours per year (h ·y-1).
D is the conversion factor for radon dose which is equal to 0.9 [mSv ·(Bq ·h)-1 ·m^3).

2.4 Assessing the potential risk of lung cancer due to radon exposure

The potential risk of lung cancer describes the expected incidences that can be attributed to inhalation of radon gas [12]. Herein, the expected annual incidence of lung cancer cases per million people (Ilc) caused by radiation dose from radon-222 was determined by eq. (2)

$$Ilc=E_{Rn}\times 18 \qquad (2)$$

Where E_{Rn} = Radon-222 effective dose.

3- RESULTS AND DISCUSSION

The mean and the annual range of 222Rn concentration in indoor (21.1) Bq/m^3. The range concentrations of background air of 222Rn are (70-3) Bq/m^3. The highest and lowest concentrations of 222Rn in the indoor air (70 Bq/m^3) and (3) Bq/ m^3, respectively (TABLE I) The mean concentration of 222Rn indoor air relative to WHO and EPA standards are 21.0% and 14.0 %,the concentration of 222Rn indoor air of all homes is less than the WHO guideline and EPA standard limits[13]. The annual mean effective dose of 222Rn in Atbara is (0.509) mS/y. Effective dose by residents of Atbara is less than standard ICRP [14](1mSv/y) (TABLE IIIII) [12,13]

Table-1: 222-Rn concentrations of indoor air samples of home in Atbara, Sudan

No	Maximum ^{222}Rn concentration Bq/m3	Minimum ^{222}Rn concentration Bq/m3	Average ^{222}Rn concentration Bq/m3	No	Maximum ^{222}Rn concentration Bq/m3	Minimum ^{222}Rn concentration Bq/m3	Average ^{222}Rn concentration Bq/m3
1	44	6	17.17	16	47	12	21.5
2	22	3	13.75	17	21	6	12.75
3	18	3	10.5	18	24	9	17
4	33	6	17.2	19	24	9	17.17
5	32	12	22.83	20	24	6	18
6	20	18	19	21	21	3	12
7	36	12	24	22	27	9	19.14
8	26	23	24.5	23	26	6	17.67
9	23	6	16	24	18	9	12.75
10	45	27	36	25	44	25	34.5
11	36	22	29	26	18	6	12
12	27	15	23	27	24	16	20
13	39	15	25.75	28	41	3	21.47
14	31	18	24.5	29	32	3	16.27
15	26	15	21.2	30	70	6	29.2
Minimum					18	3	10.5
Maximum					70	27	36
Mean					30.6	10.9	20.1
World Health Organization (WHO) reference level					100		
Environmental Protection Agency (EPA) reference level					148		

Table-2: Effective dose of 222-Rn concentrations and Expected incidence of lung cancer per million people per in homes at Atbara, Sudan

No	Effective dose mSv/y	Expected incidence of lung cancer per million people per year	No	Effective dose mSv/y	Expected incidence of lung cancer per million people per year ($\times10^{-4}$)
1	0.43	7.80	16	0.54	9.76
2	0.35	6.24	17	0.32	5.79
3	0.26	4.77	18	0.43	7.72
4	0.43	7.81	19	0.43	7.80
5	0.58	10.37	20	0.45	8.17
6	0.48	8.63	21	0.30	5.45
7	0.61	10.90	22	0.48	8.69
8	0.62	11.13	23	0.45	8.02
9	0.40	7.27	24	0.32	5.79
10	0.91	16.35	25	0.87	15.67
11	0.73	13.17	26	0.30	5.45
12	0.58	10.44	27	0.50	9.08
13	0.65	11.69	28	0.54	9.75

No	**Effective dose mSv/y**	**Expected incidence of lung cancer per million people per year**	**No**	**Effective dose mSv/y**	**Expected incidence of lung cancer per million people per year ($\times10^{-4}$)**
14	0.62	11.13	29	0.41	7.39
15	0.53	9.63	30	0.74	13.26
Minimum				0.265	4.768
Maximum				0.908	16.348
Mean				0.509	9.170
(ICRP) reference level				1	

4- CONCLUSION:

To evaluate the health hazards of radon in home radiation level. The annual effective dose and excess life-time cancer risk to the residents were measured. The average of annual effective dose 0.509 mS/y indoor environments. and the estimated excess, lifetime cancer risk was 9×10^{-4}. All results are less than standard compared to global levels.

REFERENCES:

1. Elseed HG, Albashir MH, Dirar M. *Assessment of Natural Radioactivity Concentration and Dose in Surface Soil Samples from Atbara*. European Academic Research. 2016;4(7):6681-7
2. MH Albashir, Mohamed. A.H. Dahab, A.E. Elfaki, Alhag. *Determination of Radon-222 Levels and Hazards in Air Samples, Quarriers Cement Factories in River Nile State, Sudan*, Journal of Scientific and Engineering Research, 2020, 7(4):85-90
3. Elseed HG, Albashir MH, Dirar M. *Concentrations of (Fe, Ni, Zn, Mn, Cr) in Moringa Oleifera collected from River Nile state*. European Academic Research. 2016;4(8):6670-8.
4. A.Bozkurt and E.Kam, Indoor Radon measurement in the city of Edrin , Turkya, Sixth international Conference of the Balkan physical Union, 2007. 17. Mehra R, Singh S, Kumar S. Measurement of indoor radon levels in dwellings of Sirsa district, Haryana and estimation of average annual dose. J Environ Sci Eng. 2009 Apr;51(2):103-6.
5. P Theodorsson ,Measurement Weak Radioactivity ,World Scientific -1996
6. CG Sumesh, A Vinod Kumar, RM Tripathi ‹VD Puranik ,Thoron interference test of different continuous passive radon monitors ,Department of Atomic Energy ‹Environmental Assessment Division, Bhabha Atomic Research Centre‹Trombay, Mumbai, India – 2011
7. Abdul R.H. Subber ‹Noori H.N Al-Hashmi , Ali Frhan Nader , JabburH .Jebur and M.K. Khodier , Consturctasa simple radon chamber for measurement of radon detectors calibration factors , Pelagia Research Library Advances in Applied Science Research – 2015.
8. United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), 2000. Sources and Effects of Ionizing Radiation; United Nations Scientific Committee on the Effects of Atomic Radiation, USA.
9. Ismail, A.H., Jaafar, M.S. 2010. Indoor radon concentration and its health risks in selected locations in Iraqi Kurdistan using CR-39 NTDs, Bioinformatics and Biomedical Engineering (iCBBE), 2010 4th International Conference on. IEEE, Pp. 1–8.
10. https://www.sarad.de/cms/media/docs/handbuch/Manual_Radon-Scout_EN_24-03-17.pdf.
11. https://www.sarad.de/cms/media/docs/handbuch/Manual_RadonVision6_EN_16-10-2015.pdf.
12. Protection, I.C.O.R., 1994. Age-dependent doses to members of the public from intake of radionuclides: part 2 ingestion dose coefficients: a report of a task group of Committee 2 the International commission on radiological protection. Elsevier Health Sciences.
13. ICRP, 1994. ICRP Publication 66: Human Respiratory Tract Model for Radiological Protection. Elsevier Health Sciences. Hassan, V., Arash, R., Mehdi, J., Ahmad, R., Ali, H.-B.A., Wali, Y.A., Ali, D., AbdulRasool, M., Abbas, P. 2011. Demonstration of malaria situation analysis, stratification, and planning in Minab District, southern Iran. Asian Pacific J. Trop. Med., 4: 67–71.