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Original Research Article

Outdoor Background Radiation Levels in Mining Locations and Major Activity Areas of Ebonyi State, South-Eastern, Nigeria and Their Radiological Impacts

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ABSTRACT

Background: Miners and the people living close to mining sites are exposed to elevated levels of ionizing radiation with or without their knowledge. This study was designed to evaluate the outdoor background radiation levels in some selected mining locations and major activity areas of Ebonyi State, South-Eastern, Nigeria and their radiological impacts.
Materials and Methods: The levels of background radiation in these mining areas were estimated using a well calibrated International Medicom CRM-100 Digital Radiation Monitor (survey meter). A cross-sectional survey was adopted for this study. Based on standard method, the radiation monitor was held at a distance of 1.0 meters above the ground and three readings taken at each location and the mean recorded. The radiation dose rates were calculated. A descriptive statistic and inferential statistic were used to summarize the data using statistical package for social Sciences SPSS version 21.
Results: The mean dose rate for all the mining locations studied is 0.269±0.039(µSv/hr) and OAEDR of 0.470±0.068(mSv/yr). The excess life cancer risk for adult and children are 1.645 x 10^{-3} and 1.175 x 10^{-3} in the mining areas respectively. The mean outdoor Annual Equivalent Dose Rate (OAEDR) for the mining locations of Ebonyi States was 0.470±0.068 and mean of the radiation dose values recommended by UNSCEAR (2008) was 2.4± 0.48. There was statistically significance mean difference between the mean of OAEDR and the UNCEAR recommended value (p = 0.001).
Conclusion: the outdoor background radiation levels emitted from the study area are within permissible limits for the general population. Therefore, there is little risk of instantaneous radiation hazard within the mining areas of Ebonyi State.

Keywords: Absorb dose, excess life Cancer risk, radiation hazard

INTRODUCTION

Ionizing radiation poses a serious health effect to atoms of living things by damaging tissues and DNA in genes [1]. Exposures from natural radiation are the largest sources [2] of radiation exposure to human beings, and form the baseline for adding man-made sources. These include both cosmic radiation and environmental radioactivity from naturally occurring radioactive materials (such as radon and radium), as well as man-made, medical X-rays, fallout from nuclear weapons testing and nuclear accidents [3].

The biggest source of natural background radiation is airborne radon, a radioactive gas that emanates from the ground. It is produced continuously from the decay of naturally occurring radionuclides such as ^{238}U, ^{235} U, ^{232}Th. Radon and its isotopes, parent radionuclides, and decay products all contribute to an average inhaled dose of 1.26 mSv/yr [3]. Worldwide average annual effective dose from ionizing radiation from natural sources is estimated to be 2.4 mSv/yr, of which about 1.0 mSv/yr is due to radon exposure [4]. The problem of radon emission has attracted considerable attention worldwide. Radon is unevenly distributed and varies with some factors such as human activities, life style, topography, types of building materials in the areas, weather conditions, such that much higher doses apply to many areas of the world, where it represents a significant health hazards. Miners and the people living close to mining sites are exposed to elevated levels of ionizing radiation with or without their knowledge[5]. Previous studies have shown that Concentrations over 500 times the world average have been found inside buildings in Scandinavia, the United States, Iran, and the Czech Republic. Radon is a decay product of uranium, which is relatively common in the Earth's crust, but more concentrate in ore-bearing rocks scattered around the world. Radon seeps out of these ores into the atmosphere or into ground water or infiltrates into buildings. It can be inhaled into the lungs, along with its decay products, where they will reside for a period of time after exposure.

Ionizing radiation in our environment can also occur either naturally or can be produced artificially through human activities such as mining, oil exploration, nuclear weapon testing, accidental or normal releases from nuclear power reactors, and so on. Although radon is naturally occurring, exposure can be enhanced or diminished by human activities, notably house construction. A poorly sealed basement in an otherwise well insulated house can result in the accumulation of radon within the dwelling, exposing its residents to high concentrations [6].

Most communities in Ebonyi state that have on-going mining and quarrying activities experience lots of environmental pollution. Due to high level of poverty and lack of education among the indigenes of these communities, majority of them have now chosen mining over agriculture as means of livelihood. Minerals mining and quarrying activities are parts of the anthropogenic activities identified as major contributors to background ionizing radiation (BIR) level of the human inhabited environment [7]. The various mineral deposits mentioned above are known to contain naturally occurring radioactive materials (NORMs) constituting the series of radionuclides of 238U, 235U, 232Th, 222R and single radionuclide of 40K [8]. These mining activities in the areas make the people of these communities to be at risk of radiation health hazards but the impact of these mining activities on the levels of background radiation in these selected communities has not been studied. Hence, the need to assess the background radiation levels in these areas to ascertain the levels of ionizing radiation exposure to the inhabitants.

MATERIALS AND METHODS

A cross-sectional survey design was adopted for the study and was conducted in some selected mining locations and other heavy activities areas across Ebonyi state, Nigeria. Ebonyi State is one of centers of stone crushing and a lot of other mining activities in southeast Nigeria because of high deposit of solid minerals. The state is made up of 13 local government areas with each having either one or combinations of different mineral deposits in highly commercial quantities, such as table salt, lead oxide, iron ore, zinc, uranium, limestone, granite etc.[9]. Quarry mining is one of the major sources of livelihood in Ebonyi state, Nigeria and the growing demand for limestone and others have led to the establishment of different scales of quarry industries in the state. Apart from satisfying the ever growing needs of a rapidly growing population for infrastructural development and urbanization, quarrying activities have helped to provide direct and indirect jobs for many people living in the host communities and Ebonyi State is geographically located within the tropical rainforest (southeastern) region of Nigeria.

The outdoor background radiation levels at the selected mining areas were obtained using a well calibrated International Medicom CRM-100 Digital Radiation Monitor. The CRM-100 is a general purpose Geiger counter that measures alpha, beta, gamma, and x-radiation. It has a liquid crystal display (LCD) screen that shows current radiation level in users choice; milli-roentgens per hour mR/hr, Counts per minute CPM, micro-sieverts per hour µSv/hr, Counts per second CPS. An in situ (in the normal location) background radiation measurement approach was adopted following standard procedure described by Ebong and Alagoa[10] and Ugwuanyi et al.[11], in which the radiation monitor was held at a distance of 1.0 meters above the ground and the mean of (at least) three readings taken at each location was recorded. This radiation meter has a maximum response to environmental radiation during the hours of 1300 to 1600 [10], hence the readings were taken during this period for optimum results. The value of readings obtained and other details for each dumpsite were recorded and displayed in a table. For measuring mixed alpha, beta and gamma radiation, the Counts per minute CPM mode was used. The background radiation readings obtained in Counts per minute CPM were converted to µSv/hr using the relation; 10 CPM = 0.10 µSv/hr that is 100 CPM = 1 µSv/hr (CRM-100 Guide). The annual equivalent dose rate in mSv/yr of the values was calculated using the recommended outdoor occupancy factors of 0.2[4].

To convert dose rate from µSv/hr to mSv/yr for Outdoor;

Dose rate per year = X µSv/hr x Total hours in a year x outdoor occupancy factor (0.2).

Based on 24 hours a day and 365 days in a year;

The number of hours in a year will be 24 x 365 = 8760 hours.

Hence; X µSv/hr x 8760 x 0.2 = Outdoor dose rate per year.

The obtained data were analyzed using statistical package for social sciences SPSS version 21(IBM Corp. Armork. NY, 2011). Descriptive statistics (mean, standard deviation) of various background radiation values was obtained

RESULT

Table 1: Background radiation levels in the eight(8) selected active mining sites of Ebonyi

Names of Locations	Dose Rate(µSv/hr)	OAEDR(mSv/yr)
Umuoghara stone mining and quarry site Ezza-North LGA	0.248	0.434
AUC asphalt company Afikpo-Abakaliki express way Afikpo-North LGA	0.259	0.454
Josang stone quarry km 40 Enugu-Abakaliki express way ,Ishielu LGA	0.219	0.384
Akpegu Mgbo stone mine,Ohaukwu LGA	0.349	0.611
Royal Salt Ltd , Ikwo LGA	0.272	0.477
Ishiagu Enyimgba lead mine, Abakaliki LGA	0.269	0.471
Amajim Amaeka leadmine Ezza-south LGA	0.289	0.506
NJOAIC African BIT Ltd Mkpuma-Akpatakpa ,Izzi LGA.	0.243	0.426
Mean	0.269±0.039	0.470±0.068

KEYS:OAEDR=outdoor Annual Equivalent Dose Rate

Table 2. Values for Excess Life Cancer Risk (ELCR)

Activity areas	OAEDR(mean±SD)(mSv/yr)	ELCR For Adult	ELCR For children
Mining activities areas	0.470±0.039	$1.645x10^{-3}$	$1.175x10^{-3}$

Table 3: T-test for difference between mean OAEDR for mining locations and the UNSCEAR (2008) recommended value of Background radiation dose

Average Radiation Dose to Human	Mean+_SD (mSv/yr)	p-value
Average Natural Radiation Dose to Human recommended by UNSCEAR(2008)	2.4+_0.48	
OAEDR for mining locations of Ebonyi state	0.470±0.068	0.001

Result from the table showed that Josang stone quarry at km 40 Enugu-Abakaliki express way in Ishielu LGA has the lowest radiation dose rate of 0.219 (µSv/hr) and OAEDR of 0.384mSv/yr while Akpegu-mgbo stone mine, Ohaukwu LGA has the highest background radiation dose rate of 0.349µSv/hr and OAEDR of 0. 611mSv/yr. The mean dose rate for all the mining locations studied is 0.269±0.039(µSv/hr) and OAEDR of 0.470±0.068(mSv/yr)(Table 1)

The excess life cancer risk for adult and children are 1.645×10^{-3} and 1.175×10^{-3} in the mining areas respectively (Table 2). The mean OAEDR for the mining locations of Ebonyi States was 0.470±0.068 and mean of the radiation dose values recommended by UNSCEAR (2008) was 2.4± 0.48. There was statistically significance mean difference between the mean of OAEDR and the UNCEAR recommended value ($p = 0.001$)(Table 3).

DISCUSSION

The result of our study revealed that radiation dose rate and OAEDR vary from one place to another, with mining sites in Ohaukwu Local Government Area having the highest radiation dose rate and OAEDR respectively. This finding is in agreement with the findings of the studies conducted by Ayuwa et al [5] in Taraba State, and Ugwuanyi et al [11] in Nnewi Anambra State, Nigeria. The aforementioned studies also reported varied values of the radiation dose rate and OAEDR across different locations. The findings of this study is also within the acceptable range of the radiation dose rate and OAEDR recommended by the International Commission on Radiological Protection (ICRP) value of 1.0mSv/yr and 20.0mSv/yr set by Nigerian Basic Ionization Radiation Regulation for whole body of adult radiation protection. This implies that minners and inhabitants of these areas are safe. However, there could be long term variations in the consequences arising from the effects of ionizing radiation among the minners and even the inhabitants. Contrary to our finding, is the finding documented by Ademola [12] in Jos Plateau, Nigeria, which evaluated exposure to high background radiation level in the tin mining area, which reported values higher than that documented in our study. The differences in our findings could be attributed to the differences in the nature of our studies and the geographical variations of the various studies.

The excess life cancer risk for adults in the mining areas was higher than that of children. This implies that the chances of adult having cancer in these areas is high when compared with that of children. The UNSCEAR [3] recommended mean value of OAEDR was higher than the value obtained in this study and there was a statistically significant mean difference between OAEDR and the UNSCEAR recommended value. This implies that the miners and inhabitants of these areas are safe. This finding is in harmony with the finding of Ugwuanyi et al[11], which also reported safe background radiation across the various dumpsites in Nnewi metropolis, Nigeria.

CONCLUSION

The outdoor background radiation levels emitted from the study area are within permissible limits for the general population. Therefore, there is little risk of instantaneous radiation hazard within the mining areas of Ebonyi State.

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