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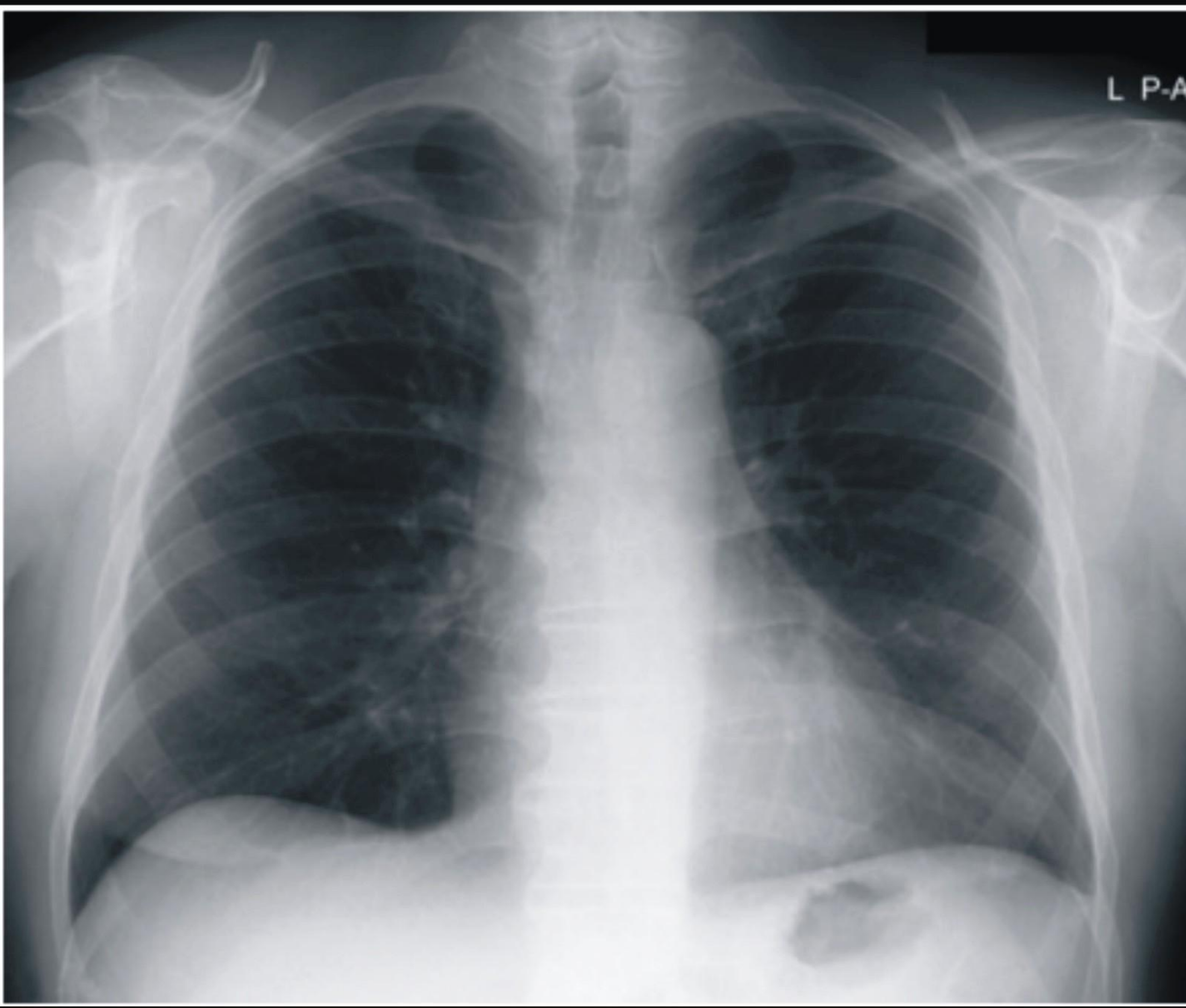

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Assessment of Background Radiation Levels at the Radiology Department of a Tertiary Hospital in North-central Nigeria

Eshiett Peter[1], *Joseph Dlama Zira[2], Egga Anita[3], Matthew Abubakar[4], Abdullahi Mundi [5], Kpaku Goriya[5]

[1]Radiology Department, Federal Medical Centre, Keffi, Nasarawa State, Nigeria.

[2]Radiology Department, Abubakar Tafawa Balewa University Teaching Hospital Bauchi, Nigeria;

*(**corresponding author**:+2348130582721, josephdlama@gmail.com)

[3]National Agency for Science and Engineering Infrastructure, Garki, Abuja, Nigeria

[4]Department of Medical Radiography, University of Maiduguri,Borno State, Nigeria

[5]Department of Physics, Nasarawa State University, Keffi, Nigeria

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ABSTRACT

Background: Background radiation has over the years become a public health concern. It is therefore, imperative to ascertain its levels within strategic areas in our radiology facility for monitoring and compliance with international standards.

Objectives: To determine the background radiation levels in the Radiology Department of Federal Medical Centre (FMC), Keffi, Nigeria.

Methodology: The design was prospective and cross-sectional and involved the measurement of background radiation levels at various locations in the radiology department. Calibrated thermo Scientific RadEye TM B20 / B20-ER survey meter, an associated scalar counter, and a stopwatch, were used for measurements at each point, based on standard guidelines recommended by the International Atomic Energy Agency (IAEA).

Results: The least mean radiation (0.11µSv/hr) was detected in the computed tomography (CT) suite while the maximum value (0.13µSv/hr) emanated from the radiographers' common room. The coefficient of variation for the Chief Radiographers office, Head of Department's office and the Radiologist's office were similar 8.3%. The radiographers' common room was slightly higher (10.9%). The main diagnostic room and seminar room had 16.7%, while it was 9.09% for the CT suite. The standard error ranged between 0.002 and 0.004. There was statistically significant difference in all test values at a level of significance of 5% ($p < 0.05$).

Conclusion: Background radiation values obtained were within recommended standards. However, there is need for regular radiation monitoring as part of radiation safety culture in our radiology facility.

Key words- Background radiation, sieviert, dose rate, radiographers, radiology

Introduction

Background radiation is the ionizing radiation present in the environment. It originates from both natural and artificial sources like cosmic radiation,and environmental radioactivity such as naturally occurring radioactive materials including radon, radium, and fallout from nuclear weapons testing and nuclear accidents[1]. Naturally-occurring background radiation is the main source of exposure for most people [1,2].

Levels typically range from about 1.5 to 3.5 millisievert/year but can be > 50 mSv/yr [2] as well. Background levels of radiation in the natural environment surrounds us at all times; it is ubiquitous [2].

Man-made radionuclides have entered the environment from activities such as medical procedures that use radionuclides to image the body, and electricity generation that uses radioactive uranium as fuel [1]. Human beings are continuously irradiated by sources outside and inside their bodies. External sources include space radiation and terrestrial radiation while the internal sources include the radionuclides that enter the body through food, water and air. Whatever its origin, radiation is everywhere in the environment and is a public health concern [2,3].

Radiation from beyond the solar system has enough energy to generate additional radiation as it passes through earth's atmosphere, creating either radionuclides in the air or secondary particles [3]. Some secondary particles reach the earth's surface most readily near the magnetic poles where the earth's magnetic field is weakest and at high altitudes where the earth's atmosphere is thinnest [3] .

Radionuclides created by space radiation are called cosmogenic radionuclides. They include tritium (hydrogen-3), beryllium-7, carbon-14, and sodium-22 [4]. Radiation that originates on earth is called terrestrial radiation. Primordial radionuclides (radioactive chemicals that were present when the earth formed about 4.5 billion years ago are found around the globe in igneous and sedimentary rock. From rocks, these radionuclides migrate into soil, water, and even air. Human activities such as uranium mining have also redistributed these radionuclides. Primordial radionuclides include the series of radionuclides produced when uranium and thorium decay, as well as potassium-40 and rubidium-87 [5]. We are surrounded by naturally-occurring radioactive elements in the soil and stones, and are bathed with cosmic rays entering the earth's atmosphere from outer space [6].

Exposure to high levels of radiation is known to cause cancer [7,8]. But the effects on human health from very low doses of radiation such as the doses from background radiation, are very hard to determine because, there are so many other factors that can mask or distort the effects of radiation [8]. The objective of this study is to determine the background radiation levels in the Radiology Department of Federal Medical Centre, Keffi, Nigeria.

Material and methods

Study setting

Keffi is one of the densely-populated towns in Nasarawa State with an estimated population of about 85,911 persons. It is located at an elevation of 338 metre above sea level. Nasarawa State is bounded in the north and west by Kaduna State and the federal capital territory, in the south by Kogi and Benue States, and in the east by Taraba and Plateau States. It is a mineral-rich area with abundant deposit of sodium chloride and bauxite.

Federal Medical Centre, Keffi

Federal Medical Centre (FMC), Keffi is located in Keffi Local Govenment Area of Nasarawa State and with close proximity to the federal capital territory. It receives an average throughput of 250 patients/week. The department of Radiology provides clinical services in diagnostic radiography, interventional radiology, ultrasound, and computed tomography (CT). As at the time of the study, it had a staff strength of two radiologists, three radiology resident doctors, six radiographers, four radiography interns and several auxiliary staff.

Method of data collection

Dosimeters used for this study were calibrated at the secondary standard dosimetry laboratory in Ibadan, Nigeria in the year 2015 when the study was carried out. The calibration was treaceable to primary standard dosimetry laboratory. Thermo Scientific RadEye TM B20 / B20-ER Survey meter, an associated scalar counter and a stop-watch were used for measurements.

The survey meter was placed at strategic points in the location at distance of 25cm from the ground levels on a table top to record readings. The survey meter was carefully checked to ensure that readings were at zero point and that the battery was in good working condition.

Seven (7) distinct locations were chosen from within the department; the main diagnostic room, CT suite, seminar room, chief Radiographer's office, radiographers' common office, Head of Radiology Department's office and Radiologists' office. Twenty (20) readings were taken at each point based on standard protocols and guidelines recommended by the IAEA. Direct reading were obtained at different locations from the survey meter in microsievert per hour (μSv/hr). Statistical package for social sciences, version 21.0, was used for analysis. Student T-test was used to compare the mean dose rate at different locations. Statistical significance was set at $p < 0.05$.

Results

The values ranged from 0.11μSv/hr to 0.13μSv/hr with a mean of 0.12μSv/hr. There was statistically significant differences in all test values at 5% ($p < 0.05$). These are summarized in Table 1

Table 1. Mean dose rate and T-test Score for various locations

s/n	Location	Mean μSv/hr	ðx	Coefficient of variation %	Standard Error	T-test
1	Main x-ray room	0.12	0.02	0.02	16.7	0.0045
2	CT Suite	0.11	0.01	9.09	0.002	0.0022
3	Seminar Room	0.12	0.02	16.7	0.004	0.0045
4	Chief Radiographer's Office	0.12	0.01	8.3	0.002	0.0022
5	Radiographer's common room	0.13	0.02	10.9	0.004	0.0045
6	Head of Departments Office	0.12	0.01	8.3	0.002	0.0022
7	Radiologists' Office	0.12	0.01	8.3	0.002	0.0022

Discussion

Naturally occurring background radiation is the main source of radiation effective dose for most humans. [6,11]. Medical procedures, such as diagnostic x-rays, nuclear medicine and radiotherapy are by far the most significant source of human-made radiation exposure to the general public [7]. National radiation protection standards are based on International Commission on Radiological Protection, ICRP, recommendations for both occupational and public exposure categories [8]. This study presented lower values than recommended by the ICRP.

The values for the background radiation ranged from 0.11μSv/hr to 0.13μSv /hr as presented in Table 1.The main x-ray room, the seminar room, the chief Radiographer's office, the Head of department's office and the Radiologists office presented with same value of 0.12μSv/hr. The lowest being the CT scan suite with a value of 0.11μSv/hr and the highest, the Radiographers common office, having 0.13μSv/hr as the mean background radiation value. Generally, natural dose rate from cosmic rays depend strongly on the altitude and slightly on the latitude. The latitude effect is due to the charged particles nature of the primary cosmic rays and the effect of the earth's magnetic field, which tends to direct ions away from the equator and towards the poles [9,10].

Cosmic radiation produces x-rays and neutrons as it penetrates through the atmosphere and the dose increases with altitude [11]. It is also possible for inhabitants of high rise buildings to receive more dose from cosmic radiation. Naturally, the x-ray environment is expected to have the highest ionizing radiation due to the combined effects of medical exposures and radioactive materials present in building materials used in the construction of the building [7,12].The radiographers may have made conscious to minimize exposure since the background dose was comparable to other locations in the department. This agrees with a comparable work carried out in Port Harcourt, Southsouth Nigeria [7].

The results of this study are lower compared with previous work at Skane Radio diagnostic centre in Jos (0.234µSv/hr) [13] , Plateau state specialist Hospital (0.276µSv/hr) [14], and the Department of Radiology and Nuclear medicine, New Mexico Veterans Administration Healthcare system, USA (0.342µSv/hr) [14]. However, compared with background radiation profile of a physics Laboratory in Port Harcourt, our values were higher [7].

Furthermore, the background radiation levels of the x-ray environment in FMC ,Keffi, is within permissible value as recommended by United Nations Scientific Effects on Atomic Radiation (UNSCEAR, 0.274µSv/hr) [16,17]. Reasons for low background could be attributed to low radioactivity within study location. Radioactivity is known to increase background radiation [13]. This is consistent with another study which also recorded lower values in Port harcourt [7] and Zambia [9], respectively.

The background radiation level assessed in this study when compared with international commission on Radiological Protection (ICRP) standard values is comparatively lower. However, a regular environmental radiation monitoring of the radiology department and its surroundings are recommended as part of the radiation safety culture.

Conclusion

The measurements of the background radiation levels at the Federal Medical Centre, Keffi, Nigeria has been carried out and it showed radiation levels within permissible limits with values of 0.11 to 0.13 µSv/hr.

Sponsorship: Nil

Conflict of interest: Nil

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