# AN EVALUATION OF BACKGROUND IONIZING RADIATION LEVEL IN FEDERAL MEDICAL CENTRE, KEFFI, NASARAWA STATE, NIGERIA

# ABSTRACT

*An evaluation of background ionizing radiation levels in Federal Medical Centre Keffi, Nasarawa State, Nigeria, objective of the is to determine the background radiation levels in each of the diagnostic rooms and other offices in the department, Determine the background radiation level outside the department in the areas close to the department. To investigate whether there are other external sources of ionizing radiation within the radiology department. To compute the average ionizing radiation level doses in the department and compare with the international council of radiation protection (ICRP) exposure limits, the study was carried out using the RadEye B20 TM electronic meter with an inbuilt Geiger Muller counter to measure the amount of radiation in each of the rooms and offices within the radiology department. The result obtained ranges from 0.11μSv/hr to 0.13 ± 0.02μSv/hr with an average background dose of 0.12μSv/hr measured within the radiology department. The amount of radiation measured within the radiology department is within the safe limit recommended as worldwide average natural dose of background ionizing radiation of 0.274μSv/hr; therefore, the radiology department of Federal Medical Centre, Keffi, background ionizing radiation dose is within permissible allowed value showing that the department and the hospital is radiological safe.*

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# DEFINITION OF TERMS

**Counter:** A device for making radiation measurement or counting ionization events.

**Ionization:** the process of producing ions.

**Geiger muller counter:** it a sensitive radiation detector composed of a dubs and scaler with gas.

**Radiation:** described a process through which energy energy emitted by one body travel through a medium or through space, to be absorbed by another body or sending rays which could be in the form of light or heat.

**Ionization radiation:** refers to any radiation process in which the individual quanta of radiated energy are able to ionize atoms or molecules of the energy absorbed.

**Exposure:** is the process by which substances get assimilated into a given body.

**Dose:** is the specific amount of substance in a body.

**Absorbed dose:** the amount of energy or photons absorbed from the radiation per unit mass.

**Nuclear medicine:** it is a branch of medicine that employ the use of radioactive isotpe in diagnosis and treatment of patients.

**Red:** radiation absorbed dose.

**Radioactivity:** is the natural and spontaneous process by which unstable atoms or element disintegrate.

# CHAPTER 1 INTRODUCTION

* 1. **BACKGROUND OF THE STUDY**

This is the ubiquitous ionizing radiation that people on earth are exposed to, including natural and artificial sources. Both natural and artificial background radiations vary depending on location and altitude.

Ionizing radiation has been employed in the diagnosis of various diseases and treatment since its discovery in 1895 by Wilhelm Conrad Roentgen.

Environmental degradation which has led to various forms of health issues and hardship has become a global concern. Industrialization (used of ionizing radiation in medicine) and poor environmental managements have resulted in the release of various kinds of pollutant in to the environment.

Background radiation which was previous attributed to cosmic sources had over the years increased due to industrialization and technological advancement apart from the radiation from atmosphere and terrestrial deposit, ionizing radiation from hospitals, diagnostic centre and medical research institute has been of utmost concern because of the established effect of radiation high doses.

There are many types of ionizing radiation available for either treatment or diagnosis worldwide. Despite it wide application in medicine, it could be dangerous if not properly handled or administered.

Exposure of individuals to radiographic examination such as computerized tomography, fluoroscopic procedure, and dental x-rays investigation, radioisotope procedures and radiotherapy investigations have contributed to increase in background ionizing radiation and radiation Levels of patients and many occupational workers (Avwiri, 2011).

Generally, radiation in the hospital comes from three main sources which are medical exposure (radiation for medical examination) cosmic/terrestrial radiation and radioactivity from the background.

(Ike, 2003).

Medical exposures are known to constitute a very good percentage of indoor background ionizing radiation.

(Hayumbu, *et al.* 1995), made it clear in their study that some of the materials used in construction of building are known to be radioactive (Hayumbu, *et al.* 1995) which increase the background ionizing radiation level of that environment.

It is also a well-established fact according to Chad Umoren, *et al*.( 2007), that chronic exposure to even low dose rate of nuclear radiations from

an irradiated building has the potential to induce cytogenic damage in humans.

(Jwanbot, *et al* 2012) in their studies carried out in Jos North central Nigeria also showed indoor ionizing background radiation to be 6.234 μsv/hr and 0.276 μsv/hr for skane radio diagnostic centre and Plateau State Specialist Hospital respectively.

Cosmic radiation: The earth with all the living organism in it are constantly bombarded by ionizing radiation from the outer space.

This radiation from the outer space primarily consist of positively charged ions from protons to iron and larger nuclei derived sources outside our solar system. This radiation interacts with atoms in the atmosphere to create an air shower of secondary radiation including x-ray, protons, alpha particles, electron and neutrons. The immediate doses from cosmic radiation is largely from neutrons and electron and this dose varies in different parts of the world based on a larger extend on the geomagnetic field and altitude. This radiation is much more intense in the upper troposphere at about 10 KM altitude and is thus of particular concern to airline crews.

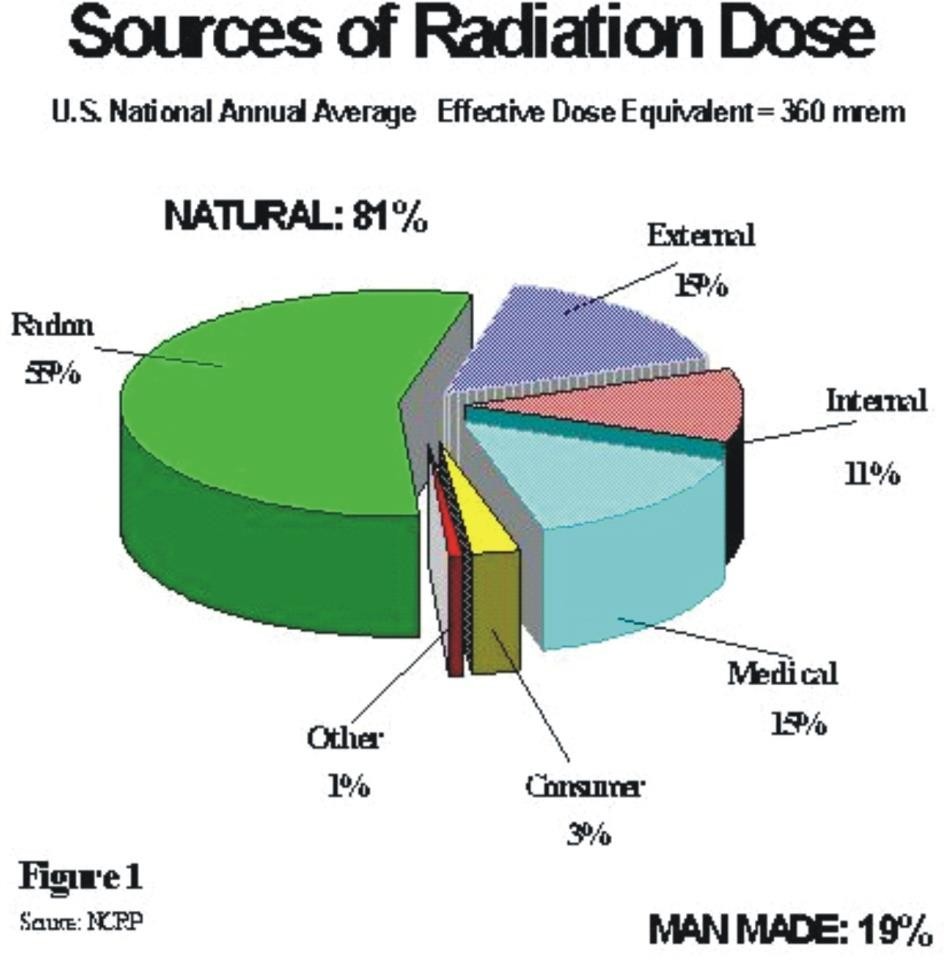


FIG 1.1 SOURCES OF RADIATION DOSE (UNSCEAR, 2008)

Radiation may be in the form of either particles or waves depending on the amount of energy transferred. Radiation may be classified as either ionizing or non-ionizing radiation. Ionizing radiation, radiation energy is propagated through the space in the form of particles.

Examples of radiation are:

Radio waves Visible light Heat

X rays.

The structure of the atom is important in understanding the origins and nature of radiation and radioactivity. Classical atomic structure suggest that in general atoms consist of dense positively charged nucleus surrounded by a number of electrons from some distance away. Though the existence of atom has been stipulated by the modern theory has long began to develop in the early 1900s.

The Bohr model of the atom is useful in illustrating the process of nuclear and atomic transformation. In 1913, Neils Bohr stated that the classical theory of didn‟t apply to orbiting electrons.

Bohr based his theory on two postulates, that electrons can only occupy specific energy levels and an atomic electron can only change energy( give up or absorb)by changing from one level to another..

The visible light, radio waves, and UV rays are all forms of radiation propagated as waves.

The electromagnetic waves transport energy and momentum from one sources of the receiver the waves also travel at the speed of light in a vacuum.

Ionizing radiation played a very great part in the evaluation of all the components of both living and nonliving things. The effective dose due to ionizing radiation for the public varies depending on their places of aboard, their occupation personal habits, diet, building types and houses utilization pattern (Malathic, *et al*. 2005).

Generally, national radiation protection standard are based on international commission on radiological protection, (ICRP), the recommendation on both occupational and public exposures, categories (ICRP, 1990).

The Federal Medical Centre Keffi evolved from the then General Hospital Keffi which was established in 2000 by the pronouncement of the federal government of Nigeria.

The hospital, federal medical centre has several units of specialist hospital which may contain radiation emitting devices in the radiology department. Based on this, the investigation of the background radiation level of the hospital to ascertain its radiation burden and to provide base line data for future studies become very important.

Medical procedures, such as diagnostic x-rays, nuclear medicine and radiotherapy are by far the most significant source of manmade radiation exposure to the general public.

# STATEMENT OF THE PROBLEM

Degradation of our environment and it attendant effect has led to various forms of hardship and health issues has become a thing of great concern globally.

Industrialization and poor environmental managements have resulted to the release of various forms of pollutants into the environment which include some form of radiation called background radiation.

Background ionizing radiation which was originally attributed to cosmic sources has over the years increased greatly due to advancement in technology, apart from the radiation from the atmosphere and terrestrial deposits.

Ionizing radiation from the hospital and medical research institutes from medical examination or investigation and radio therapy treatments using various forms of radiation equipment has been of great concern because of the known effects of high dosages. (Avwiri, 2011).

Radiation from the hospital comes in three different sources medical exposure cosmic and terrestrial radiation and radioactivity from the background (Ike, 2003) medical exposures gives a good percentage of background ionizing radiation.

This study, seek to measure the amount of background radiation and compare with the standard values to ensure that the values are within the safe limits.

# AIMS AND OBJECTIVE OF THE STUDY

* + 1. **Aim**

To evaluate background ionizing radiation level in radiology department Federal Medical Centre Keffi.

# Objectives

* + - 1. To determine the background radiation levels in each of the diagnostic rooms and other offices in the department.
      2. Determine the background radiation level outside the department in the areas close to the department.
      3. To investigate whether there are other external sources of ionizing radiation within the radiology department.
      4. To compute the average ionizing radiation level doses in the department and compare with the international council of radiation protection (ICRP) exposure limits.

# SIGNIFICANCE OF THE STUDY

The study determine the level of background ionizing radiation in the radiology department of the medical centre and compare the results with the international safe standard values to ensure the staff and patient in the department are not exposed to high level of ionizing background radiation.

# JUSTIFICATION AND LIMITATION OF THE STUDY

It is a well-established fact that ionizing radiation at high doses can cause harm to living organisms but there is uncertainty about it effect at low level of ionizing radiation dose. At the level of dose routinely encountered by members of the public and most present day occupationally exposed persons, there is little or no epidemiological evidence of it health effects. The measurement or determination of background ionizing radiation to ensure that the radiation level is not high enough to cause any biological effect and to control in the event of high background radiation and determine the sources of high dose of radiation as such study has not been conducted in Federal Medical Centre, Keffi, since it establishment.

The evaluation of background ionizing radiation level research is limited to only the background ionizing radiation within the radiology department of the Federal Medical Centre Keffi, the analysis and discussion are based on the it interactions with human and how the radiation level can be reduced to the acceptable standard.

# SCOPE OF THE STUDY

Experimental study expected to cover the entire offices and diagnostic rooms in the department of radiology Federal Medical Centre Keffi.

The extent to which this evaluation of the background ionizing radiation level in radiology department is carried out is relevant to the risk to health in the event of high doses.

# AREA OF STUDY/ BRIEF HISTORY/ LOCATION OF FEDERAL MEDICAL CENTRE, KEFFI

The area of study is the department of radiology, Federal Medical Centre, Keffi. The choice of the hospital radiology is because the hospital is located centrally in the north central zone of the country and the findings from this research will serve as a guide to other zone in the country especially other radio diagnostic centres.

Federal Medical Centre Keffi came in to existence in July 2000 following the take over from the formal General Hospital Keffi by the federal government.

The centre is located about 52 kilometers from FCT Abuja. By virtue of its strategic location on the very busy traffic along the Akwanga-Keffi- Abuja Road that links other parts of the country, the north-east, north- central and south –eastern road network. The federal medical centre is often refers to as the nation the safe valve.

# CHAPTER TWO LITERATURE REVIEW

* 1. **REVIEW OF RELATED WORKS**

Several studies have been done on the evaluation of background radiation on various countries in the world. In Nigeria, also several studies have been done.

In a study done on the evaluation of background ionizing radiation level in the Braithwaite memorial specialist hospital, Port Harcourt, River State Nigeria by (Okoye, *et al.* 2013), showed that the result obtained range from

o.16 ± 0.01 μsv/hr to 0.14 ± 0. μsv/hr with an average of 0.146 ± 0.2 μsv/hr for indoor measurement with the x-ray departments and location within the hospital, 0.19 μsv/hr to 0.12 ± 0.01 μsv/hr with an average of 0.136± 0.02 μsv/hr for indoor measurements in ward within the hospital those values when compare to the standard of 0.274 μsv/hr recommended as worldwide average natural dose of background radiation are within permissible allowed value.

In a similar study done in Nasarawa State, (Keffi and Akwanga towns in central Nigerian on the effective dose from natural background radiation in Keffi and Akwanga towns, by Ramli, *et al*. (2014), the result showed mean indoor and outdoor annual effective dose of Akwanga were 1.9± 0.13 M μsv/yr and 0.31 ± 0.04 μsv/yr respectively. The radiation levels in both populated

towns were found to be within the safe limit for the area of normal background set by NUSCEAR 2.4 μsv/yr).

In another study on natural background radiation measurements of a base station in Yalvac county by Halim, *et al.* (2009) showed and arithmetic mean radiation dose changing from 1.92 ± 2.27 μsv/yr having been obtained and compared with radiation dose limits of a body. Using Geiger Mueller LND T12. Olarinoye, *et al.* (2010) in their studies on the measurement of background Gamma radiation levels at two tertiary institutions in Mina Nigeria, in an insitu measurement of background radiation level carried in the vicinity in three difference campuses of two major tertiary institution in Mina using a portable Geiger Mueller tube base environmental radiation dosimeter. The dose rate obtained are at the Niger State College of Education Mina (NCM) to 0.171 μsv/hr, at the Federal University of Technology Bosso Campus (FUTG) it was between 0.137 μsv/hr and 0.184 μsv/hr.

In a similar study on the evaluation of background ionization radiation level in some selected dumpsite in Delta State Nigeria, the mean background ionization radiation level obtained values in all the dumpsite ranges from 0.017±0.006 mr/hr to 0.016 ± mr/h.( Avwiri *et al.* 2014).

All the background ionization radiation value obtained exceeded the normal world average BIR level of 0.01 3 mR/hr the mean absorbed dose rate value ranger from 1.430 msv/yr to 1.54 msv/y.

Avwiri, *et al.* (2001) on the assessment of background ionization radiation of oil spillage site in Obodo Greek in Gokana LGA of River State, Nigeria, an in situ measurement was done using a well calibrated nuclear radiation meter, (Radaler 100) and a geographical positioning system (GPS) the mean background ionization radiation values obtained from the east, west and south cardinal direction of the spill site are 0.0164 ± 0.004 mR/hr, 0.0164 ± 0.004 mR/hr, 0.0171 ± 0.006 mR/hr and 0.0155 ± 0.004 mR/hr respectively while the

mean equivalent dose rate value are 1.3287 ±0.002 msv/yr, 1.2278 ± 0.001

msv/yr, 14380 ± 0.002 msv/yr and 1.3035 ± 0.002 msv/y. Both the background ionization radiation and equivalent dose rate level obtained values are higher than the normal world average background radiation level of 0.013 mr/hr and

1.0 msv/yr respectively. The study showed that the crude oil spill site environment may have been impacted but there is an effect on the immediate health implication, but rather it will pose some long term health side effects. Measurement of indoor and outdoor background ionizing radiation levels in Kwali general hospital Abuja.

A study done by (James, *et al.* 2015) using calibrated Geiger miller counter (Atomtex AT 1117M) radiation monitor, the dose equivalent obtained from the result ranges from 0.100 ± 0.001 msv/hr to 0.124 ± 0.007 msv/hr with an average value of 0.107 ± 0.003 msv/hr for outdoor measurement respectively. The values obtained are below standard background radiation of 0.133 msv/hr

the study showed that the annual dose equivalent rate is 0.750 ± 0.020 msv/yr and 0.189 ± 0.005 msv/yr for indoor outdoor measurements.

# IONIZATION RADIATION EXPOSURE WITH MEDICAL IMAGING

The vast majority of artificial exposure to ionizing radiation in general population comes from its uses in medicine and allied health for diagnosis and therapy.

Medical ionization radiation contribute 0.4 msv to the annual average dose of radiation (>14%) (Edward, *et al.* 2015). The most frequently used modality of radiation is diagnostic x-ray examinations.

In conventional radiography the effective dose that a patient received depends on several factors which are the beam energy and filtration which increases the average energy to result in an acceptable image and the collimation in radiography which allows only the area of interest and reduce scatter and unnecessary exposure to other tissue and the use of grids to reduce scatter and finally patient size determine the amount of radiation to be given to the patient.

# HIGH BACKGROUND RADIATION AREAS

Human, animals and plants have been exposed to natural radiation since the creation of life. Interestingly, life evolved in a radiation field that

was much more intense than to day. The natural and man-made effective annual radiation dose for the world population is about 3 mSv which include exposures to alpha radiation from radon and its progeny nuclides, nearly, 80% of this doses (2.4 mSv) comes from natural background radiation, although levels of natural radiation can vary greatly. According to the study by ( Mortazavi, *et al.* 2010), Ramsar, a northern coastal city in Iran, has area with some of the highest levels of natural radiation measured to date. The effective dose equivalents in very high background radiation areas (VHBRAS) of Ramsar in particular in Talesh Mahalleh are a few time higher than the ICRP recommended radiation dose limits for radiation workers.

The people living in houses in this area receive annual doses as high as 132 mSv from external terrestrial sources. The radioactivity of the high background radiation areas of Ramsar is due to Ra -226 and it decay products which have been brought to the surface by the waters of hot springs. There are more than nine hot springs with different concentration of Radium in Ramsar that are used as spas by both tourist and residents.

According to the results of a survey performed to date the radioactivity seems primarily to be due to the radium dissolved in mineral water and secondarily to travertine deposit elevated levels of thorium combine with lesser concentration uranium (Sohrabi, 1990). Due to extra

ordinary levels of natural radiation in the area in some of the cases 55-200 times higher than normal background areas. Some expert in the world have suggested that dwellers have such high levels of natural radiation need urgent remedial action. (Sohrabi, 1990).

The preliminary results of cytogenetically, immunological and hematological studies on the residents of high background radiation area of Ramsar have been previously reported (Mortazavi, et al., 2001), (Ghiass\,. *et al.*2002) and (Mortazavi, *et al*.2002), suggesting that exposure to high levels of natural background radiation can induce radio adaptive response in human cells. The lymphocytes of some individual showed synergistic effect after pre-treatment with low dose of radiation (Mortazavi, *et al.* 2002). None of the resident of high background radiation areas such response. Current radiation protection recommendation are based on the prediction of an assumption on linear non threshold dose effect relationship (LNT) beneficial effects and of detriment after irradiation with low levels of ionizing radiation, including a prolonged exposure to high level of natural radiation of the inhabitants of (HBRAs) are inconsistent with LNT linear non threshold.( Mortazavi, *et al,* 1999).

A preliminary result suggest that prolonged exposure to very high levels of natural radiation could lead to the induction of radiation resistant among expose individuals which has interesting implication for any aspect

of radiation protection policy. The phenomenon of radio resistance in living organism has been a matter of interest for the scientists. Experiments on drosophila rebulosa collected in the woods of high background radiation area in Brazil indicate the addition of some genes causing the radio- resistance found in the floes compare to flies collected from the adjacent control woods. This can also be possible in human which genetic alterations have occurred over the span of many generations to induce radio resistance noted in the study.

# TUMOR MARKERS

Following epidemiological studies that showed high or excess cancer rate in the area of high background radiation based on such epidemiological figure a study was done to shed light on the impact of high levels of background radiation on cancer induction. The levels of background gamma radiation as well as indoor radon was determined using RDS-110 and CR dosimeter, 35 participant from high level background radiation areas, and 35 participants from normal background radiation areas were selected randomly to participate in the study.

Commercial Elisa Kits (Sandwich Type Elis A lest) were used to

measure the serum level of PSA. The study showed that among the eight biomarkers investigated, the means of PSA. CA 15.3, CA 12.5, CA 19.9 and

AFP concentration between the high background radiation areas and the non-background radiation area were not significantly different.

# BACKGROUND RADIATION

This is the ubiquitous ionizing radiation that people on earth are exposed to, including natural and artificial sources. Both natural and artificial background radiations vary depending on location and altitude.

# NATURAL BACKGROUND RADIATION

The natural background radiation or ionizing radiation are the radioactive materials that are found throughout nature. Detectable amount of this ionizing radiation occur naturally in soil, rocks, water, vegetation and air from which it is initiated and ingested into the organism‟s body. In addition to this internal exposure, human also received external exposure from radioactive materials that remain outside the body and cosmic radiation from space. The worldwide average natural dose to human is about 2.4 mSv/yr

.(NUSCEA,2008)

This is four times the worldwide average artificial radiation exposure which in the year 2008 amounted to about 0.6 mSv/yr. In developed rich countries like Japan and US, artificial exposure are on the average greater than the natural exposure due to greater access to medical imaging. In Europe, average natural background exposure by country ranges from under

2 mSv annually in the United Kingdom to more than 7mSv annually for some groups of people in Finland (Natural Radiation in Western Europe).

# SOURCES OF NATURAL BACKGROUND RADIATION

Cosmic radiation: The earth with all the living organism in it are constantly bombarded by ionizing radiation from the outer space.

This radiation from the outer space primarily consist of positively charged ions from protons to iron and larger nuclei derived sources outside our solar system. This radiation interacts with atoms in the atmosphere to create an air shower of secondary radiation including x-ray, protons, alpha particles, electron and neutrons. The immediate doses from cosmic radiation is largely from neutrons and electron and this dose varies in different parts of the world based on a larger extend on the geomagnetic field and altitude. This radiation is much more intense in the upper troposphere at about 10 KM altitude and is thus of particular concern to airline crews.

# AIR

The biggest sources of natural background radiation is radon, a

airborne radon a radioactive that emanates from the earth crust (ground) radon and it isotope parent radionuclide and decays products all contribute to an average inhaled dose of 1.26 mSv/yr, radon is unevenly distributed and varies with whether such that much higher doses apply to many areas of the world where it represent a significant health hazard.

Concentration over 500 times the world average have been found inside building in Scandinavia United States, Iran and the Czech Republic. (United Nation Scientific Committee, 2006). Radon is a decay product of uranium which is known to be relatively common on earth but more concentrate in ore bearing rocks scattered around the world.

# TERRESTRIAL SOURCES (RADIATION)

The major source of ionizing radiation in this source of ionizing radiation are the major radionuclide of potassium, uranium and thorium and their respective decay products which are external to the body which like the radium and radon are intensively radioactive but occurs in low concentration. Most of which have being decreasing due to radioactive decay since the formation of the earth because there is no significant amount currently transported to the earth.

# FOOD AND WATER

Some of the essential component of the human body, mainly potassium and carbon have radioactive isotope that add significantly to our background radiation doses. An average human contains about 30 milligram of potassium 40(40k) and about 10 nanogram (10-8g) of carbon 14, excluding internal contamination by external radioactive materials. The largest component of internal radiation exposure from biological functional component of the human body is from potassium 40.

* 1. **Photoelectric Effect:** Background radiation doses in immediate vicinity of particles of high atomic number material within the human body, have a small enhancement due to the photoelectric effect (Pattison, *et al.* 2009).
  2. **Neutron Background:** The most of the natural neutron background is a product of cosmic radiation rays interacting with the atmospheres. The neutron energy peak at around 1MeV and rapidly drops above at sea level. The production is around 20 neutron per second per kilogram per material interacting with the cosmic rays.
  3. **Internal Radiation:** All people have internal radiation, mainly from radioactive potassium 40 and carbon 14 inside their bodies from birth and therefore, are sources of exposure to other people or organisms. It is clear that the variation in dose from one person to another is not as great as that association with cosmic and terrestrial sources of radiation. (USNRC, 2014).

# ARTIFICIAL/MANMADE BACKGROUND RADIATION

**I Medicals:** The world average human exposure to artificial radiation is 0.6 mSv/a. primarily from medical imaging. This medical component can range much higher with an average of 3mSv per year across the USA population (ionizing radiation exposure of the population of United State (ICRP,1990 No,160) other man made contributors to background radiation include

smoking, air travel, radioactive building materials, nuclear weapons testing, nuclear power accidents and nuclear industry operations.

A routine typical chest x-ray delivers 0.02 mSv (2Mrem) of effective dose, (Wall, *et al.* 1997). A dental x-ray delivers a dose of about 5 to 10 mSv, (Wall. 1997). The average American receives about 3mSv of diagnostic medical dose per year. Countries with the lowest level of health care receive almost none. All radiation treatment or therapy for various diseases also account for some dose of background ionizing radiation both on individuals and those around them.

1. **Consumer Items:** Cigarette contains polonium 210, originating from the decay products of radon which stick to tobacco leaves; heavy smoking results in radiation dose of 160 mSv to localized spots at the bifurcation of segmental bronchi in the lungs from the decay of polonium 210. This is not readily comparable to the radiation protection limit since radiation protection deals with the whole body doses while the dose from smoking is delivered to a very small portion of the body. (Dade *et al.* 2013). Traveling by air also causes increase exposure to radiation dose from cosmic radiation. The average extra radiation dose to flight personnel is 2.19 mSv/yr, (HPS, 2013).
2. **Occupational Exposure:** The ICRP recommended limiting occupational radiation exposure to 50 mSv (5rem) per year and 100 mSv (10rem) in 5 years (ICRP, 2007). At an AIEA conference in 2002. It was recommended that occupational doses below 1-2 mSv per year do not warrant regulatory scrutiny. (MTCD, 2004).
3. **Nuclear Accidents:** Under normal circumstance, nuclear reactors release of radioactive gases, which causes negligibly small radiation exposures to the public events classified on the international nuclear event scale as accidents typically do not release any additional radioactive substances into the environment. Large releases of radioactivity from nuclear reactor are extremely rare. Until present there are two major civilian accidents that occurs, Chernobyl accident and the Fukushima nuclear accidents which causes very high contamination, the Chernobyl accidents was the only one that causes immediate death. The total doses from Chernobyl accident was from 10-50 mSv over twenty years for the inhabitant of the affected area with most dose received in the first years for liquidator.

There was over 28 death from radiation syndrome following the incident, (W.H.O, 2006) while the dose received from the Fukushima incident was 1-15 mSv for the inhabitant within the area.

Thyroid doses for children were below 50 mSv 167 cleanup workers received doses of above 100 mSv with 6 of them receiving more than 25 mSv I e the Japanese exposure limit to emergency response workers.( Geoff, *et al.* 2012).

# NUCLEAR FUEL CYCLE

The nuclear regulatory commission, the United States environmental protection agency and other US and international agencies required that licensees limit radiation exposure to individual members of the public to 1mSv (100 Mrem) per year.

# OTHER SOURCES OF BACKGROUND RADIATION

Radiation is also emitted from coal plants in the form of radioactivity fly ash which ingested or inhale into the system by those around the coal plants and also in co-operated into crops.

A 1978 paper from Oak Ridge National Laboratory estimated that coal fired power plants of that may contribute a whole body committed dose of 19 mSv/a for older plants or 1 mSv/a for newer plants.

# BIOLOGICAL EFFECTS OF RADIATION

We look at the effect of radiation to a living organism in term how it impact living cells. For low level radiation exposure the biological effect are so small there may not be detected, the body is able to repair damage from radiation, chemicals and other hazards.

The following occurs when living cells are exposed to low level radiation;

1. Repair themselves, leaving no damage
2. Die and be replaced, much like millions of body cells do every day
3. Incorrectly repair themselves resulting in a biophysical change.

The data link between radiation exposure and development of cancer are based on population receiving high level of exposure to ionizing radiation. (NRC, 2008), much of the information comes from survivor of the atomic bombs in Japan and people who have received ionizing radiation for medical purpose such as cancer therapy, cancer are associated with high dose exposure to radiation (greater than 50,000 Mrem or 50 mSv – 500 times the NRC limit to the public) such cancers include but not limited to breast, bladder, colon, leukemia, lever, lungs esophagus ovarian multiple myeloma and stomach cancers.



# FIG.2.1. RADEYE B20 SURVEY METER

The thermo scientific Radeye TM B20/B20 ER models are the next generation of improved quick survey and precision scalar measurement meters. These modern and compact survey meters measures alpha, Gamma, beta and x radiation surface contamination.

This pocket size instruments can also be used accurately for dose rate surveys if used with optional energy compensated filler (17 KeV -3 MeV) for emergency response applications. The alpha and beta contamination measurements can be discriminated using the optional alpha blocker filter.

The RadEye B20 will automatically switch to the proper measuring unit if any auto detector. This automatic function helps to avoid accidental misuse and to quickly change from one measurement to the next.

# FEATURES OF RADEYE B20 AND REDEYE B20-ER

The survey meter has a huge internal data memory for both scalar results and continuous data recording, bright-backlit LCD display plain text messages different language can be selected and easy adoptions to different tasks by supervisor configuration, calibration, selection and measuring units.

The versality of the operation modes makes scalar/times with preset count and preset time for sample measurement. Continuous rate meter mode for frisker operation and dose rate mode also has an audible indication, single pulse or chirper mode proportional to count rate.

The RadEye survey is a form of the Geiger Muller tube an exceptionally robust non-energy dissipative instrument and has a mean dead time of 208 ± 40 μS (Sigalo, 2004). This makes an effective and sensitive instrument for radiation monitoring (Chad umoren, 2006) important environmental radiation survey have used the Geiger Muller tube such as the survey of BIR levels resulting from fertilizer production operation (Ebong, 1992) estimate of radiation profile of sub-industrial areas of Port Harcourt,

Nigeria (Arwiri, 2002) and the determination of BIR levels within the

premises of a multinational company involved in oil and gas operation in the Niger Delta region, Nigeria (Sigalo, 2000).

# BASIC RADIATION PHYSICS

1. The spectral properties of radiation

It is essential that we distinguish between the different wavelengths of light, as the interaction of light with solids, particles and gases is strongly sensitive to wavelength. As a result, the relationship between intensity and wavelength generally carries much of the information about the objects which the radiation has touched. Because the wavelength can vary over many orders of magnitude, we use various notations for describing it. The most commonly used length unit for wavelength is the micrometer (i.e. micron) defined as one millionth of a meter. For very short wavelengths, the nanometer is useful (i.e. one trillionth of a meter). For longer waves, the millimeter, centimeter or meter can be used. By convention, the full spectrum of electromagnetic radiation is subdivided in to the following ranges: gamma rays, x-rays, ultraviolet, visible, infrared, microwave and radiowaves.

These ranges can be further subdivided; for example, the ultraviolet (.12 to .4 microns) can be divided into the far UV (.2 to .3 microns) and the near UV (.3 to.4 microns). The visible range (.4 to .7 microns), that range to which

the human eye is sensitive, can be crudely divided into blue (.4 to .5

microns), green (.5 to .6) and the red (.6 to .7). A much finer subdivision by wavelength in the visible range is used in the study of color. The infrared (.7 to about 400 microns) is divided in to near infrared (i.e. NIR; .7 to 2 microns), middle infrared (2 to 5), the “thermal” infrared (5 to 100) and the far IR. Microwaves (1mm to 1 meter) are often divided into “bands”; such as X-band, L-band etc., based on wavelength. Radio wave subdivisions are referred to by their wavelengths directly (e.g. 2-meter, 6-meter) by HAM radio operators.

In describing how much radiation is present with a particular wavelength, care must be taken to use precise language. Except for certain theoretical studies, or perhaps for laser light, a precisely specified wavelength (e.g. 0.755555555…microns) would have no radiation. Only a RANGE of wavelengths (e.g. 0.75 to 0.76 microns) would have finite radiative energy. If the specified range is sufficiently small, the amount of radiation is proportional to the range. That is, the amount of radiation between wavelengths 0.75 and 0.76 microns (range 0.01) would be ten times that falling between 0.755 and 0.756 (range 0.001). Mathematical functions describing the field of radiation by wavelength must carry the extra unit (inverse wavelength) so that they can be multiplied by the incremental wavelength range to get the amount of radiation (see the discussion of the Planck function). Two alternate indicators of spectral position are used, the

wavenumber and the frequency. The wavenumber (i.e. the number of waves in a given unit of distance) is defined as the inverse of the wavelength. It could have units of inverse centimeters for example. The frequency is the number of waves passing a location per unit time. It is related to wavelength by frequency = c/wavelength, where c is the speed of light. Frequency is usually given in hertz, kilohertz, megahertz, etc. One „hertz‟ is one cycle per second.

For those of us who reside on planet earth, the absorptive property of the earth‟s atmosphere is an important factor in remote sensing. Unfortunately, the earth‟s atmosphere is opaque to large portions of the electromagnetic spectrum.

Radiation reaching the observer in these wavelengths will have been absorbed and re-emitted by the atmosphere and will not contain information about the object we are trying to observe. Luckily, there are several discrete portions of the spectrum for which the atmosphere is transparent. We call these spectral segments “atmospheric windows” or just “windows”. The most important windows are:1) The visible/NIR window (0.4 to about 1 micron), 2) The IR window (in the thermal IR between 8 and 12 microns) and 3) the microwave/radio window (wavelengths longer than about 1 cm.). Almost all remote sensing of “objects” uses these windows. The non-window wavelengths are being used for remote sensing of the atmosphere itself (i.e. mapping out its temperature, density and chemical composition). The human eye has evolved to

use the visible window. The location of the windows is determined by the gases existing in the atmosphere. For earth, these include the air (N2, O2 and Argon) and the greenhouse gases (H2O, CO2, O3, N2O, etc.)

On occasion, it is useful to describe the total amount of radiation, without regard for its spectral distribution. An example of such a quantity is the Solar Constant; the total radiant energy, per unit time and area, received from the sun, at the position of the earth‟s orbit. This quantity has a value of S=1380 Watts/m2.

A spectrally resolved solar constant, describing how much each wavelength contributes to the sun‟s radiant energy would have units of Watts/m2/micron.

1. The angular distribution of radiation.

There are two common ways of describing the amount of radiation present in a certain environment: angularly resolved and unresolved. The term intensity (or radiance) refers to the angularly resolved description of radiation; i.e. the information needed to create an image. The human eye, and a video camera, are devices to detect radiance. Such devices have an optical focusing system and an array of detectors on the focal plane. Hundreds or thousands of brightness values at each wavelength are needed to describe the radiance.

When describing the angular distribution of radiation (i.e. the radiance), we must use precise language. If we ask how much radiation is approaching the sample point from a precisely specified direction (. azimuth= 26.5555… degrees and elevation

1. Interaction of radiation with matter

The interaction of radiation and a solid surface involves two processes: emission and reflection. Typically, the radiation beaming away from any surface is the sum of emitted and reflected light. For most surfaces and wavelengths, the emission of radiation is close to the Black Body approximation described by the Planck Function

where h = 6.6262 x 10-27 erg sec (Planck‟s constant)

k= 1.3806 x 10-16 erg deg-1 (Boltzman‟s constant) c = 2.99793 x 1010 cm/sec (speed of light)

When evaluating this function, T is the object temperature in Kelvins and λ is the

Wavelength in centimeters. The Planck can be written in several ways. The particular form given above is based on wavelength λ, and the constants are given in the cgs system of units. If the constants were given in the SI (or mks) system, then the input and output quantities should also be in the SI system.

This formula, one of the triumphs of statistical physics, is well treated in advanced texts. We only mention a few interesting aspects. First, B gives the radiance emitted from a surface, that is, power per unit area per unit solid angle per unit wavelength. For example, B could have the (SI) units of watts/m2/steradian/m (or some equivalent units such as watts/m3/steradian). To obtain a quantity with units of power (i.e. Watts), increments of emitting area (dA), conical solid angle (dΩ) and wavelength range (dλ) must be chosen. Then, the power emitted by that area into the specified cone, within the specified wavelength range is Bλ(T)dA dΩ dλ

When plotted against wavelength (λ), B has a bell shape with a peak at λmax; the wavelength being most profusely emitted by the object. This special wavelength is given by Wien‟s Law; λmax=C/T; where the constant C=2898 microns\* Kelvins-1.

Thus, hotter objects tend to emit at shorter wavelengths. As an example, a body with a temperature of 10C (283K) will emit most strongly at a wavelength of

λmax= 2898/283= 10.2 microns (i.e. in the thermal infrared). The sun, with a surface temperature of 6000K, will emit most strongly at λmax= 2898/6000=

0.483 microns (i.e. in the middle of the visible range)

Note that the chemical or physical nature of the emitting object does not influence B; it depends on temperature only. The Black Body radiance described by B is also predicted to be isotropic; independent of angle. If the Black Body radiance is integrated over all wavelengths and angles, the total irradiance is found to be F=σ\*T4 with units Watts/m2

This is the Stephan-Boltzman Law, and σ is the Stephan-Boltzman constant. The temperature in this formula must always be given in kelvins.

Under certain circumstances, thermal emission can be significantly less than predicted by the Black Body Laws. To describe this behavior we define the emissivity (ε ) as the ratio of the actual emission to the Black Body prediction. Emission is following the Black Body rule. If 1<ε, the body emits less than the Black Body Law predicts. The emissivity varies with wavelength. In the thermal Infrared part of the spectrum, ε seldom drops below 0.9 while in the distant microwave spectrum ε can be as small as 0.2 or 0.3.

The other essential radiation process occurring at solid surfaces is reflection. There are two type of reflection: specular and diffuse. Specular reflection is dominant from a smooth, shiny surface such as a mirror, a waxed car fender or a glassy smooth lake. The reflected fraction of the incoming beam has an angle equal to the incident angle. If the incident light is a single narrow beam then the

reflected light will also be beam-like. If the incident light is isotropic, like sky- light, the reflected light will also be isotropic. Little or no color shift occurs during specular reflection; the spectral content of the reflected light is the same as the incident light. The reflected light contains no information about the chemical composition or temperature of the object.

Diffuse reflection occurs on rough surfaces such as paper, cloth, grass, matte- finished paint, snow, soil, etc. To a good approximation, diffuse reflection is Isotropic, even if the incident light is in a tight beam. Most important, diffuse reflection usually includes a color shift due to partial absorption. If the incident light is white (i.e. an equal mixture of red, green and blue) a red reflection, for example, will occur by absorption of green and blue. In this way, the reflected light Carries away information about the chemical composition of the object. As the object temperature plays little or no role in reflection, the reflected light contains no temperature information. Clearly, it is the process of diffuse reflection that much of remote sensing practice, as well as human color vision.

To characterize the reflective properties of a surface, we define the reflectivity (or reflectance) R.

R= reflected light/incident light

Since the reflected light can never exceed the incident light (note: We are neglecting emission here.), the quantity R can never exceed unity. Note that the reflectivity may be a strong function of wavelength. A particular surface may absorb some wavelengths while reflecting others. In practice, there are three ways to measure reflectivity. Each one requires some measurement of incident and reflected radiation, either a flux (F) or a radiance (I).

1. ratio of fluxes

If it is possible to measure the incident and reflected fluxes (Fi and Fr), then the reflectivity is R=Fr/Fi (1)

1. Incident flux and reflected radiance

If it is possible to measure the incident flux (Fi) and the reflected radiance (Ir), assumed isotropic, then the reflectivity is R=π\*Ir/Fi (2)

This formula follows from the Formula for flux in a situation with isotropic radiance over a hemisphere.

# CHAPTER THRE MATERIALS AND METHOD

This chapter explains the instrument and procedures used in this experimental research work.

# MATERIALS

Rad Eye TM B20 and B20-ER multi-purpose survey meters is used for the measurement of background radiation, using alkaline battery of 9.0 volts, a scientific calculator, note /readings taken book, pen and computer (laptop). **INSTRUMENT FOR DATA COLLECTION**

Rad Eye TM B20 and B20-ER multi-purpose survey meters is used for the measurement of background radiation. The first responders need to quickly identify mixed radioactive surface contamination in facility and field environments. It is a multi-purpose survey meter which is simple, robust, reliable contamination and dose rate measurement tools for characterizing alpha, beta, Gamma, and x-ray radiation.

# RADEYE B20 SURVEY METER

The thermo scientific Radeye TM B20/B20 ER models are the next generation of improved quick survey and precision scalar measurement meters. These modern and compact survey meters measures alpha, Gamma, beta and x radiation surface contamination.

This pocket size instruments can also be used accurately for dose rate surveys if used with optional energy compensated filler (17 KeV -3 MeV) for emergency response applications. The alpha and beta contamination measurements can be discriminated using the optional alpha blocker filter. The RadEye B20 will automatically switch to the proper measuring unit if any auto detector. This automatic function helps to avoid accidental misuse and to quickly change.

This instrument is part of the RadEye family with high end standalone meter with 500hrs operation time with 2AAA batteries, rechargeable NIMH cells can be used. It is a multipurpose survey meter, offers consistent, reliable results in any application requiring radiological survey of flat surface. Model B20 is for normal measurement while B20-ER is for high range measurement. The instrument measures directly in µSv/ hr.

# METHOD

The method of background radiation measurement employed used to evaluate this investigation was the use a radiation monitor with an in build Geiger muller counter tube with direct radiation measurement given in microsevert per minute operating dose rate to determine the background ionizing radiation level. To adequately evaluate the background ionization level we took twenty (20) set of reading in each of the delineated areas

within the radiology department, with five sets of reading taken in each angle of the room randomly. The measuring devices uses the Geiger muller tube to detect the radiation. The measuring devices generate a pulse of electric current each time radiation passes through the device and causes ionization. Each of pulse is electrically detected and registered in mSv/hr. the RadEye was held above the ground level ( 1 meter above) close to the wall around the four angles of the each of the rooms. The device was turn on measurements were taken after a beep sound that indicate the statistical validity of the reading on the display of the monitor. Readings were taken with immediate direct measurement.

The research design is an experimental study design.

The sample size population was seven target areas delineated for the study within the radiology department of the Federal Medical Centre, Keffi. In collecting the data, an assembly involving RadEye B20 survey meter, an associated scale and a stopwatch were utilized. In each of the seven location for the study twenty (20) readings were made and the analyzed using statistical methods.

The target areas delineated for the study within radiology department are:

* + 1. The main x-ray room
    2. The computerized tomography CT Scab suited
    3. The seminar room
    4. The chief radiographers office
    5. The radiographers general office
    6. The head of radiologist department office
    7. The consultant radiologist office

To adequately cover the designated target area and to reduce error, twenty (20) readings were taken in each of the target areas.

A conversion factor of ICPM= 0.044 mSv/A based on the calibration Done b5y Sigalo and briggs-Kamawa (Sigalo, 2004) will be applied but the RadEye B20 survey meter has the capacity of reading in μSv/hr (dose rate), as such the conversion was not used as direct readings were obtained from the meter in micro sievert per hour (µSv/hr).

# METHOD OF DATA ANALYSIS

The method adopted in analyzing the data collected is the tabular, bar charts and graphical representation the SPSS software version 14 was also employed in the analysis of the collected data.

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# CHAPTER FOUR

**PRESENTATION OF RESULT AND DATA ANALYSIS**

# Table 4.1 Dose Rate Values from the Main X –Ray Room

|  |  |  |  |
| --- | --- | --- | --- |
|  | Dose Rate Values (μSv/hr | X-X | (X-X)2 |
| 1 | 0.10 | -0.02 | 0.004 |
| 2 | 0.09 | -0.03 | 0.0009 |
| 3 | 0.10 | -0.2 | -0.0009 |
| 4 | 0.09 | -0.03 | 0.0001 |
| 5 | 0.09 | -0.01 | 0.0001 |
| 6 | 0.11 | -0.01 | 0.001 |
| 7 | 0.10 | -.02 | 0.004 |
| 8 | 0.12 | 0 | 0 |
| 9 | 0.12 | 0 | 0 |
| 10 | 0.13 | 0.01 | 0.0001 |
| 11 | 0.14 | 0.02 | 0.0004 |
| 12 | 0.13 | 0.01 | 0.0001 |
| 13 | 0.14 | 0.02 | 0.0004 |
| 14 | 0.14 | 0.02 | 0.0004 |
| 15 | 0.13 | 0.02 | 0.0004 |
| 16 | 0.12 | 0 | 0 |
| 17 | 0.12 | 0 | 0 |
| 18 | 0.11 | -0.01 | 0.0001 |
| 19 | 0.11 | -0.01 | 0.0001 |
| 20 | 0.12 | 0 | 0 |

X=0.12 ∂=0.02

# Table 4.2 Dose Rate Values from the CT Scan Suite

|  |  |  |  |
| --- | --- | --- | --- |
| S/N | Dose Rate Values (μSv/hr | X-X | (X-X)2 |
| 1 | 0.10 | -0.01 | 0.001 |
| 2 | 0.09 | -0.02 | 0.0004 |
| 3 | 0.10 | -0.1 | -0.0001 |
| 4 | 0.12 | -0.01 | 0.0001 |
| 5 | 0.11 | 0 | 0 |
| 6 | 0.10 | -0.01 | 0.001 |
| 7 | 0.19 | -0.02 | 0.004 |
| 8 | 0.08 | -0.03 | 0.0009 |
| 9 | 0.09 | -0.02 | 0.0004 |
| 10 | 0.10 | -0.01 | 0.0001 |
| 11 | 0.11 | 0 | 0 |
| 12 | 0.10 | -0.01 | 0.0001 |
| 13 | 0.11 | 0 | 0 |
| 14 | 0.11 | 0 | 0 |
| 15 | 0.12 | 0.01 | 0.0001 |
| 16 | 0.12 | 0.01 | 0.0001 |
| 17 | 0.12 | 0.01 | 0.0001 |
| 18 | 0.11 | 0 | 0 |
| 19 | 0.11 | 0 | 0 |
| 20 | 0.12 | 0.01 | 0.0001 |

X=0.12 ∂=0.02

# Table 4.3 Dose Rate Values from the Seminar Room

|  |  |  |  |
| --- | --- | --- | --- |
| S/N | Dose Rate Values (μSv/hr | X-X | (X-X)2 |
| 1 | 0.10 | -0.02 | 0.0004 |
| 2 | 0.11 | -0.01 | 0.0001 |
| 3 | 0.10 | -0.2 | -0.0004 |
| 4 | 0.11 | -0.01 | 0.0001 |
| 5 | 0.10 | -0.02 | 0.0004 |
| 6 | 0.10 | -0.02 | 0.0004 |
| 7 | 0.11 | -0.01 | 0.0001 |
| 8 | 0.14 | 0.02 | 0.0004 |
| 9 | 0.15 | 0.03 | 0.0009 |
| 10 | 0.13 | 0.01 | 0.0001 |
| 11 | 0.15 | 0.03 | 0.0009 |
| 12 | 0.15 | 0.02 | 0.0004 |
| 13 | 0.14 | 0.03 | 0.0009 |
| 14 | 0.12 | 0 | 0 |
| 15 | 0.11 | -0.01 | 0.0001 |
| 16 | 0.11 | -0.01 | 0.0001 |
| 17 | 0.11 | 0 | 0 |
| 18 | 0.13 | -0.01 | 0.0001 |
| 19 | 0.13 | 0.01 | 0.0001 |
| 20 | 0.12 | 0 | 0 |

X=0.12 ∂=0.02

# Table 4.4 Dose Rate Values from the Chief Radiographer’s Office

|  |  |  |  |
| --- | --- | --- | --- |
| S/N | Dose Rate Values (μSv/hr | X-X | (X-X)2 |
| 1 | 0.11 | -0.01 | 0.0001 |
| 2 | 0.03 | -0.01 | 0.0001 |
| 3 | 0.12 | 0 | 0 |
| 4 | 0.13 | -0.01 | 0.0001 |
| 5 | 0.12 | 0 | 0 |
| 6 | 0.11 | -0.01 | 0.001 |
| 7 | 0.10 | -0.02 | 0.0004 |
| 8 | 0.12 | 0 | 0 |
| 9 | 0.13 | 0.01 | 0.0001 |
| 10 | 0.14 | 0.02 | 0.0004 |
| 11 | 0.13 | 0.01 | 0.0001 |
| 12 | 0.12 | 0 | 0 |
| 13 | 0.11 | -0.01 | 0.0001 |
| 14 | 0.12 | 0 | 0 |
| 15 | 0.11 | -0.01 | 0.0001 |
| 16 | 0.09 | -0.03 | 0.0009 |
| 17 | 0.11 | -0.01 | 0.0001 |
| 18 | 0.10 | -0.02 | 0.0004 |
| 19 | 0.11 | -0.01 | 0.0001 |
| 20 | 0.12 | 0 | 0 |

X=0.12 ∂=0.02

# Table 4.5 Dose Rate Values from the Radiographer’s General Office

|  |  |  |  |
| --- | --- | --- | --- |
| S/N | Dose Rate Values (μSv/hr | X-X | (X-X)2 |
| 1 | 0.11 | 0.23 | 0.0005 |
| 2 | 0.10 | 0.03 | 0.0009 |
| 3 | 0.13 | 0 | 0 |
| 4 | 0.12 | -0.01 | 0.0001 |
| 5 | 0.14 | -0.01 | 0.0001 |
| 6 | 0.13 | 0 | 0 |
| 7 | 0.14 | 0.01 | 0.0001 |
| 8 | 0.15 | 0.02 | 0.0004 |
| 9 | 0.14 | 0.01 | 0.0001 |
| 10 | 0.13 | 0 | 0 |
| 11 | 0.13 | 0 | 0 |
| 12 | 0.12 | -0.01 | 0.0001 |
| 1K | 0.12 | -0.01 | 0.0001 |
| 14 | 0.13 | 0 | 0 |
| 15 | 0.14 | 0.01 | 0.0001 |
| 16 | 0.15 | 0.02 | 0.0004 |
| 17 | 0.14 | 0.01 | 0.0001 |
| 18 | 0.15 | 0.02 | 0.0004 |
| 19 | 0.14 | 0.01 | 0.0001 |
| 20 | 0.15 | 0.02 | 0.0004 |

X=0.12 ∂=0.02

# Table 4.6 Dose Rate Values from the Head of Department’s Office

|  |  |  |  |
| --- | --- | --- | --- |
| S/N | Dose Rate Values (μSv/hr | X-X | (X-X)2 |
| 1 | 0.10 | -0.02 | 0.0004 |
| 2 | 0.09 | -0.03 | 0.0009 |
| 3 | 0.10 | -0.2 | -0.0004 |
| 4 | 0.09 | -0.03 | 0.0009 |
| 5 | 0.10 | -0.02 | 0.0004 |
| 6 | 0.10 | -0.02 | 0.0004 |
| 7 | 0.11 | -0.02 | 0.0004 |
| 8 | 0.12 | 0 | 0 |
| 9 | 0.13 | 0.01 | 0.0001 |
| 10 | 0.12 | 0 | 0 |
| 11 | 0.12 | 0.01 | 0.0001 |
| 12 | 0.12 | 0 | 0 |
| 13 | 0.13 | 0.01 | 0.0001 |
| 14 | 0.12 | 0 | 0 |
| 15 | 0.13 | 0.01 | 0.0001 |
| 16 | 0.12 | 0 | 0 |
| 17 | 0.12 | 0 | 0 |
| 18 | 0.11 | 0.01 | 0.0001 |
| 19 | 0.14 | 0.02 | 0.0004 |
| 20 | 0.18 | 0.06 | 0.0036 |

X=0.12 ∂=0.02

# Table 4.7 Dose Rate Values from the Consultant Radiographer’s Office

|  |  |  |  |
| --- | --- | --- | --- |
| S/N | Dose Rate Values (μSv/hr | X-X | (X-X)2 |
| 1 | 0.10 | -0.02 | 0.0004 |
| 2 | 0.11 | -0.01 | 0.0001 |
| 3 | 0.10 | -0.2 | -0.0004 |
| 4 | 0.10 | -0.02 | 0.0004 |
| 5 | 0.11 | -0.01 | 0.0001 |
| 6 | 0.11 | -0.01 | 0.0001 |
| 7 | 0.10 | -0.02 | 0.0004 |
| 8 | 0.11 | -0.01 | 0.0001 |
| 9 | 0.11 | -0.01 | 0.0001 |
| 10 | 0.12 | 0 | 0 |
| 11 | 0.13 | 0.01 | 0.0001 |
| 12 | 0.11 | 0 | 0 |
| 13 | 0.13 | 0.01 | 0.0001 |
| 14 | 0.12 | 0 | 0 |
| 15 | 0.13 | 0.01 | 0.0001 |
| 16 | 0.12 | 0 | 0 |
| 17 | 0.13 | 0.10 | 0.0001 |
| 18 | 0.14 | -0.02 | 0.0004 |
| 19 | 0.13 | 0.01 | 0.0001 |
| 20 | 0.14 | 0.02 | 0.0004 |

X=0.12 ∂=0.02

# Table 4.8 T.test Score for the Seven Location

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| S/N | Location | Mean X | OX | Coefficient  of Variation | Standard Error | T-test |
| 1 | Main X-Ray  Room | 0.12 | 0.02 | 0.02 | 16.7 | 0.0045 |
| 2 | CT Scan 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  General Office | 0.13 | 0.02 | 10.9% | 0.004 | 0.0045 |
| 6 | Head of Dept  Office | 0.12 | 0.01 | 8.3% | 0.002 | 0.0022 |
| 7 | Consultant  Radiographer‟s Office | 0.12 | 0.01 | 8.3% | 0.002 | 0.0022 |

**Table 4.9 Correlation Using the SPSS Software**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Correlations | Mean | Standard Deviation | Coefficient of  Variance | Standard Error |
| Mean | Pearson | 1 | 0.54 | 0.135 | 0.54 |
|  | correlation |  | 0.211 | 0.775 | 0.211 |
|  | significance |  | 7 | 7 | 7 |
|  | (2-tailed) |  |  |  |  |
| Standard | Pearson | 0.135 | 0.864\* | 1 | 1.000\* |
| Deviation | correlation of | 0.773 | 0.12 |  | 0.000 |
|  | significance | 7 | 7 | 7 | 7 |
|  | (2-tailed) |  |  |  |  |
| Standard | Pearson | 0.54 | 1.000\*\* | 0.864\* | 1 |
| Error | correlation of | 0.211 | 0.000 | 0.12 |  |
|  | significance | 7 | 7 | 7 | 7 |
|  | (2-tailed) |  |  |  |  |

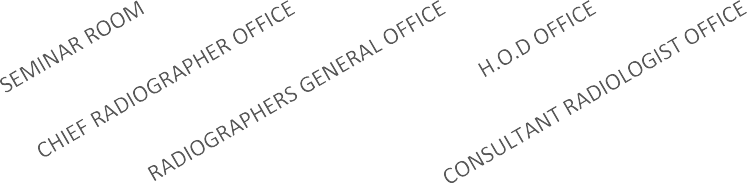
\* Correlation is significant at the 0.05 level (2-tailed)

\*\* correlation is significant at the 0.01 level 92-tailed) NB = = 7 (Sample Size)

**Dose** (μSv/hr )

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | |  |  |  |  |  |
|  |  |

# Fig.2.2: Dose rate values compared to standard for radiology department FMC keffi.



0.3

0.25

0.2

0.15

0.1

0.05

0

**Location**

Series1 Series2

# CHAPTER FIVE

# DISCUSSION, CONCLUSION AND RECOMMENDATIONS

* 1. **DISCUSION**

The result obtained in the study from the radiology department of the Federal Medical Centre, Keffi; ranges from 10μSv/hr ± 0.02μSv/hr which is below the world standard background ionizing radiation level of 0.274μSv/hr recommended as the world average natural dose of background radiation (ICRP and NCRP,1990).

The radiographer general office according to our study has the highest value of background ionizing radiation recorded of 0.13μSv/h which is still within the permissible allowed value of background ionization radiation dose. The increased in dose or rather the high value compare other areas study within the department of radiology could be due to the number of radiographers and medical imaging scientist in the room during the measurement. This is in agreement with the fact that human being also gives out certain proportion of radiation, because the essential component of the human body is mainly potassium ad carbon which has radioactive isotope that add significantly to background radiation dose. The human body contains about 30 milligram of potassium 40 and 10 nanogram of carbon 14. (NSNRC, 2014).

According to Pattison, *et al.* (2009). The background radiation dose in immediate vicinity of the particle of high atomic number material within the human body has a small enhancement due to the photoelectric effect.

The main X-ray room, which contains one installed X-ray direct digital machine and two mobile unit, has a background ionizing radiation dose value of 0.12μSv/hr despite that it is established fact the X-ray increased the amount of background radiation through the process of scattered radiation and heat dissipating from the tube, the value obtained when measured showed that the background ionizing radiation is within the permissible value that is within the recommended standard value of 0.274μSv/hr (ICRP, 2008). This background radiation value obtained could be due to the fact that x-ray machine were not powered or in operation when the study was done; primarily because the aim of the study was to study exclusively the background ionization radiation.

The computer tomography (CT) scan suite showed a radiation value of 0.11μSv/hr. Generally, the computer tomography equipment is known to give very high amount of radiation more than the conventional x-ray machine, but the study showed that the value of dose of background ionizing radiation measured in the conventional x-ray room was high than that

obtained in the CT suite, under the same operating condition, meaning, the equipment was not powered or in operation during measurement.

The low dose value obtained from this suite could be due to high level of ventilation and the ambient condition of the room. The air conditioner in computer tomography room are highly functional and work constantly 24 hour a day without been powered off.

It is clear from this research work that proper ventilation could help to reduce the amount of background radiation. This is because other areas within the radiology department that are not effectively ventilated has higher value than this. Other areas studied within the radiology department such as the seminar room, the chief radiographer‟s office, the head of department office (HOD), and the consultant radiologist office has the background ionizing radiation value of 0.12μSv/hr as presented in chapter four which is also lower than the standard recommended by (UNSCEAR, 2009, ICRP, 2008).

Generally, the mean value for each of the areas studied within the radiology department is lower than general average of the department. Usually, the radiology department is expected to have the highest amount of background

ionizing radiation when compared with the entire hospital (Tsekus, 2014).

But due to the conscious effort of the trained personnel of the department, genuine effort and maximum global practices are adopted to keep the radiological burden of the department at a permissible value.

Generally, the results are lower when compared with the similar studies done in Braithwaite Memorial Specialist Hospital Port Harcourt River State, Okeye, *et al.* (2013) also lower than that previously done at radio-diagnostic centre, Jos, Plateau State Specialist Hospital (Jwanbot *et al*. 2012), and the department of radiology and nuclear medicine, New Mexico Veteran Administration Health care System, United State of America (Mettler *et al.* 2008). This is higher when compared with the radiation profile in a physics laboratory by Chad Umoren, *et al.,* (2007). This could be due to the fact in hospital there are other sources of low emitting ionizing radiation. Furthermore, radiation burden of the hospital is within the permissible value of UNSCEAR and also lower than that of industrial area (Avwiri, *et al.* 2009).

In similar vein, the values obtained in this study is lower when compared with a similar study done in Keffi and Akwanga towns by, (Termizi *et al.* 2014) on the effective Dose from natural background radiation.

# CONCLUSION

The evaluation of the insitu background ionizing radiation of radiology department Federal Medical Centre, Keffi, has been carried out. The research study showed background ionizing radiation to be within permissible limits. Some of the rooms within the radiology where radiation level is higher should be well ventilated as a precautionary measure in reducing high radiation exposure to the individual there.

# RECOMMENDATIONS

An intensive background radiation study should be done in the entire hospital and the value compared with international standard. Despite the fact that the effective value obtained from this study falls within the safe zone of 0.13μSv/hr compared with the international standard of 0.274μSv/hr by UNSCEAR for background ionizing radiation. I therefore suggest that;

* + 1. The offices and diagnostic room within the radiology department should be well ventilated.
    2. Based on this, the management of hospital should provide good and very efficient air conditioner to reduced radiation free radical and reduce the temperature level within the department.
    3. Patient reception room should be well ventilated and the wall lead lined to prevent the escape of radiation during operation or activity involving the use of ionizing radiation.

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