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Understanding and Reviewing the Concept of Background Radiation in Everyday Life – its Prevention and related aspects

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ABSTRACT

In this manuscript, we aim to present some crucial aspects related to the background radiation (which also includes highly energetic radioactive radiation present in our background or surroundings). The term Background radiation in a layman way includes all the sorts of radiation from all sources surrounding us in our background, due to any radioactive trace (unstable nuclei) or process like nuclear reaction (fusion or fission), or even the radiation contribution from external cosmos (from supernova explosions and/or any other astronomical processes). Notably, the cosmic radiation impact could be very less due to fact that most of the high energy cosmic showers are repelled by the magnetic field of earth. However, its role in the background cannot be out-rightly rejected. In practical sense, the most of the contribution to the background or radioactive radiation is by the radioactive traces present in our environment. This could be in the form of air, water, soil, concrete walls, paint, medical devices, or even the food we consume. In this present paper, we have presented the basic information and showcased the various critical aspects related to the background radiation. This includes brief information about the measurement and methodologies involved in the analysis of the background radiation. Detrimental effect of radioactive radiation on humans as well as methods to prevent or minimize the exposure of harmful and highly energetic radioactive radiation is also discussed. Nevertheless, the information presented is not exhaustive but could summarize the crucial details which could provide overall glimpse of detection of highly energetic radioactive radiation. One should note that the background radiation exposure can be very harmful if sustains at higher levels for longer times in the background (i.e. bombarding humans with dosage more than the prescribed permissible limits).

KEYWORDS

Background radiation; Radioactive traces; Cosmic radiation; Environmental radioactivity; High-energy radiation; Radiation sources; Radiation measurement; Detection methodologies; Human health effects; Radiation exposure; Dosimetry; Radiation protection; Permissible dose limits

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INTRODUCTION

In our daily life, we either knowingly or many a times unknowingly, get exposed to more or less dosages of radiation from both - natural sources such as cosmic rays and sunlight, as well as, man-made sources like X-rays machines and other medical facilities. While the restricted and focused radiation exposure for curing some critical diseases could be beneficial. At the same time any uncontrolled, prolonged or high dosage can cause serious health risks. The radiation exposure is highly dangerous as it is invisible, odourless, and silent and goes completely undetectable till any visible or serious effects are observed. It often goes unnoticed and the humans exposed to it remain unaware of how much radiation they are being exposed to in their day-to-day life. This article discusses about some common sources of radiation that can be present around us, what potential risks can be associated with prolonged exposure, and practical strategies to reduce and prevent unnecessary radiation exposure are suggested. We will also provide brief information about the different principle methods to detect the nuclear radioactive radiation. This is necessary because when radioactive radiation gets into our environment at high levels leading to emission of severely strong radiation dosage from our background, leads to highly destructive consequences.

1. HARMFUL AND LESS-HARMFUL RADIATION:

Radiation is a type of energy that is present all around us which arises from any source or medium from all across the Universe, which exits beyond the limits of space and time. However, here we will focus on the background radiation which is present around us and engulfs us from all our surroundings. One of the main and major component background radiation is radioactive radiation which could be emitted from any radioactive source or trace, or any reaction (fusion or fission) taking place in the Universe. One should note that most of the radiation from Cosmos or outer space termed as the cosmic radiation is blocked or hindered by the magnetic field of the earth. Therefore, the component or contribution of cosmic radiation to background radiation is very less. However, our surroundings constitute toward the major component of background radiation. There are high chances that if in any area or zone the background radiation is at high level, it would be mostly due to the radioactive trace or presence of radioactive elements in any form. Anyhow, the source or the cause of high background radiation can be categorized as a natural or man-made. Constant exposure to radiation may pose non-reversible harm to human health. One should need to learn and must be conscious and aware of the nature of radiation and its types in order to shield them by taking suitable measures and precautions.

Radiation can be divided into two types: i.e., Ionizing radiation, which is considered as harmful radiation and, Non-ionizing, which is generally considered as less harmful which may not impact the human cells significantly [1]. Both are explained below.

1.1 Ionizing Radiation

Ionizing radiation has understood to have enough and sufficient energy to knock out tightly bound electrons from atoms causing ionization. The presence of high level of background radiation (X-rays, radio waves, and radioactive radiation etc.) in any specific zone, even if it is due to its major constituent, i.e. radioactive radiation is of such an impact (causing ionization) then it can destruct not only the human cells but damage DNA and other cellular structures present in living organisms. In case of radiotherapy or nuclear medicine treatment, a focused, precise and small dose within controlled limits can be beneficial, whereas, long, accidental or intentional exposure above the regulatory limits can lead to mutations in DNA, and can potentially cause cancer, birth defects, infertility, and even cell death [2]. Children and foetus are especially vulnerable because developing bodies are more sensitive to radiation exposure [3]. High dosage or repeated exposure over the time can also increase the risk.

1.2 Non-Ionizing Radiation

Non-ionizing radiation is considered as a lesser energy radiation which does not have sufficient energy to ionize atoms or affect the molecules. It is generally considered lesser harmful, though it can still have biological impact at high intensities or with continuous exposure for long times. Ultraviolet radiation can induce skin cancer and eye damage; Infrared and microwaves can cause heating and tissue damage with intense exposure. Some studies suggest possible links between long-term exposure to certain non-ionizing radiations (like radiofrequency from mobile phones) can cause health risks, but available evidence in literature is mixed [1,4].

Depending upon what aspect of radiation is being evaluated Radiation measurement is expressed in specific physical quantities.

The units to measure the radioactivity are given below

1. **Becquerel (Bq),** where 1 Bq = 1 disintegration/sec
2. **Curie (Ci),**1 Ci = 3.7×10^{10} disintegrations/sec
3. **Rutherford (Rd),**1 Rd = 10^{6} disintegrations/sec

The absorbed dosage which is the energy absorbed by matter per unit mass or the energy deposited by radiation into matter is measured by the followings

1. **Gray (Gy),** where 1 Gy = 1 joule/kg
2. **Radiation absorbed dose(rad),**where 1 rad = 100 erg/gram (C.G.S.)
   1 Gy=1 J/kg=100 rad.

Equivalent Dose(or effective dose) accounts for biological damage by combining the amount of radiation absorbed and the biological effects of that type of radiation

1. **Sievert (Sv)**

Equivalent Dose (in Sv) = Absorbed Dose (in Gy) x w_R, where (w_R) is radiation weighting factor. This factor is a number assigned to each type of radiation based on its ability to cause biological damage.

2. **roentgen equivalent man(rem),** where 1 rem = 0.01 Sv

There are some instruments and practical methods which is used to detect and measure the radiation in real world scenarios. Most of the radiation detectors detect radiation through the methods that rely on the fact that ionizing radiation creates ionization or excitation in a material, which can be measured as an amplified electrical signal or a flash of light.

They are generally composed of a detector, signal processor electronics, and a data output display device. They can measure different aspects of radiation depending upon their design and operating mode. There are three main types of radiation detector categories:

1) Gas-Filled Detectors:

A gas-filled detector is composed of enclosed gas volume with two electrodes (anode and cathode). It works when incident radiation travels through the gas, causing excitation and ionization of atoms, and molecules of the gas, which in turn produces electron-ion pairs. A high electric filed is set up between detector electrodes which exert electric forces to move the negative electrons towards the anode and the positive ions towards the cathode. The fast response of a gas-filled detector is dominated by the movement of electrons as they are lighter and therefore reach drift velocity much faster compare to positive ion which is heavier and have much slower response time. The electrons accelerate and are collected at the anode almost instantly which creates a short-lived surge of current in the circuit connected further the voltage (voltage pulse) quickly rises and then falls back to zero as the charges are collected and the current ceases, leaving a distinct, temporary signal for each individual radiation event.By counting these pulses over time, the detector measures the count rate (counts per second) which indicates the radiation field (strength or concentration of radiation in the surrounding area).Depending upon detector response to ionizing radiation which is primarily determined by the applied voltage across the electrode's, gas-filled detectors can be designed to operate in various modes for counting different types of radiation [5,6].

A) **Geiger-Müller Counter (Geiger counter):** A Geiger-Müller Counter [7] (or Geiger counter) is a type of gas-filled radiation. It consists of a cylindrical tube as a cathode and a central wire as an anode. The tube is filled with gas and have thin window to allow particle to enter without being absorption within the counter window. G.M Counters are excellent for detecting presence of low levels of radiation. But distinguish of different types of radiation particles or measurement their of energy is lesser detectable by this gas filled detection system **[5,6].**

B) **Ionization Chamber:**Ionization chamber is a sealed chamber use to measure the intensity of ionizing radiation. It also consists of a gas-filled chamber and two electrodes. Typically, a low voltage is applied between the cathode and anode so to prevent any gas amplification. This means the output signal is exactly equivalent to the energy divided by the energy required to create a single electron-ion pair, this make sure that there will be no secondary ionization. The resulting current therefore is directly proportional to the amount of ionization which makes the detector ideal for precisely measuring the total energy deposited by the radiationmaking it more useful for quantifying radiation levels in an environment.

C) **Proportional counter:** A proportional counter operates at a voltage high enough to cause a phenomenon called gas amplification or a Townsend avalanche. When radiation enters the detector, it ionizes gas atoms, creating a small number of electron-ion pairs. The strong electric field then accelerates these electrons to the point where they can cause secondary ionization, creating a cascade of thousands of new electron-ion pairs. The size of the resulting electrical pulse is directly proportional to the energy of the initial radiation event. This allows the detector to not only count radiation particles but also to determine their energy and distinguish between different types of radiation [5,6].

2) Scintillation Detectors:

Scintillator detectors consist of a material called scintillator that produces a flash of light when an ionising radiation interacts with it. This luminescence occurs due to excitation and de-excitation of atoms and molecules of the material, when de-excitation occur the deposited energy is released as photons producing fluorescence light. A photomultiplier tube (PMT) converts these faint light flashes into strong electrical signals. The intensity of the light is proportional to the energy of the radiation particle therefore allowing scintillation detectors to not only detect radiation but also measure its energy and identify the specific radioactive isotopes present [5,6]. Based on the type of material used, scintillationdetectors are of two types

A) **Inorganic Scintillators:** Inorganic scintillators [5,6] are typically dense, high atomic number crystals, they are composed of alkali halides (sodium iodide or cesium iodide) and have high light output. Further there are two types of inorganic crystal scintillators: pure or Intrinsic crystals which has no impurities added to it and extrinsic which is doped with an activator such as Thalliumto increase its light outputefficient for radiation detection.

B) **Organic Scintillators:** organic scintillators are of class of aromatic compounds and composed of organic solvent and additives(solute) hydrocarbons i.e. compounds containing benzene ring structure. Some of its types are: pure organic crystals, organic liquids and plastics. The scintillation process in the organic scintillatoroccurs due to molecular transition regardless of its physical state. It has fast response time as compared to inorganic scintillators.

3) Semiconductor detectors:

Semiconductor detector have solid-state materials, which do not have enough free charges to act as a conductor or high resistivity to act as an insulator. For semiconductor material, according to band theory of solids, have valence band, conduction band and a relatively narrow forbidden energy gap. This gap prevents electrons in the valence band from moving into the conduction band unless they are provided with sufficient energy to excite them, allowing them to move and conduct electricity. A semiconductor detector is essentially a reverse-biased p-n junction. This creates a depletion region, which is free of charge carriers and acts as the active detection volume. When radiation particle interacts with the depletion region, it causes liberation of Electrons leaving behind a positively charged hole in the crystal lattice. An electric field is applied across the depletion region by reverse bias voltage. This field rapidly sweeps the liberated electrons towards the positive electrode and the holes towards the negative electrode. This movement of charge constitutes a tiny current pulse. The total charge collected Is directly proportional to the number of electron hole pairs created when a radiation particle incident on the depletion region. Therefore, detecting radiation as well as measuring energy. Some common types of semiconductor detectors are silicon detectors, germanium detectors and cadmium zinc telluride detectors [5,6].

4) Passive Detectors (Dosimeters):

A dosimeter is a device used for measuring ionizing radiation exposure. It measures the cumulative dose absorbed by a person or an object over a period of time, unlike a counter, which measures the rate of radiation events. A dosimeter measures the total energy deposited, which gives us a direct relation to potential biological damage. The device usually measures in gray (Gy), which is the absorbed radiation energy, or in equivalent dose (sievert, Sv) [8]. There are two kinds of dosimeters.

A) **Passive Dosimeters:** The most common one is a Thermo-Luminescent Dosimeter (TLD**)**. It measures exposure by measuring visible light emitted from a sensitive crystal. These crystals store energy from radiation exposure. When heated later, they release this stored energy as light, and its intensity is directly proportional to the absorbed dose. Another passive dosimeter is a film badge. These are small pieces of photographic film that darken when exposed to radiation. The degree of darkening is a measure of the total dose [8].

B) Active Dosimeters: These are electronic personal dosimeters (EPD's) which gives real-time values of radiation dose and can alert the individual wearing one if a specific dose rate exceeds a pre-set limit. An active dosimeter works on the same principle as Geiger-Müller (GM) counters or semiconductor detectors, generating a small electrical pulse when radiation particles enter the detector. The internal electronics count these pulses and convert the count rate into a digital readout of the radiation dose or dose rate. This allows the user to monitor their exposure continuously, providing an immediate alarm if a pre-set radiation level is exceeded. [8,9].

2. OUTCOMES OF RADIATION EXPOSURE

Radiation, particularly ionizing type, interacts with living tissues in the body at the atomic and molecular levels. Depending on the type, dosage, and duration of exposure to the radiation it can result in various biological effects. When ionizing radiation passes through the body, it stores energy in cells and tissues. This energy can irreversibly damage the DNA by breaking chemical bonds or by creating reactive oxygen species (free radicals) that further harms biological components [10].

2.1 Cellular and Molecular Effects

- **DNA Damage:** Ionizing radiation can cause single-strand and double-strand breakage leading to DNA damage. Although single-strand breaks may get gradually repaired, but double-strand breaks is a more severe kind of damage which is more difficult to get fixed and may lead to mutations, chromosomal aberrations, or permanent cell death **[**10].
- **Cell Death:** Severe damage to cells, can trigger cell death (which is termed as apoptosis), resulting in fewer functional cells in tissues [10].
- **Inflammatory Response:** Damaged DNA and cellular components can stimulate inflammatory pathways leading to the release of cytokines and chemokines that further alter tissue functions drastically [11].

2.2 Tissue and Organ Effects

- **Acute Effects**: When high doses of radiation are delivered over a short period it can cause immediate tissue injury and disrupt the functioning of organs. It can then show acute effects such as skin redness, loss of hair, radiation burns, and, at very high doses, acute radiation syndrome (ARS), which can be fatal [12].

- **Hematopoietic Syndrome:** In human body, feeble damage to a lesser number of blood cells get synthesized since radiation can damage the bone marrow, leading to Immunological suppression, anaemia, increased risk of infection, and bleeding [10].
- **Gastrointestinal and Other Syndromes:** High dosage can also harm the stomach lining, causing nausea, vomiting, diarrhoea, and weaken the functioning of other vital organs [10].

2.3 Long-Term and Stochastic Effects

- **Cancer:** Even at lower doses ionizing radiation can directly or indirectly (due to any source present precariously present in the background) increase the risk of developing cancer such as lung cancer, gastrointestinal tract cancer, bone cancer, liver cancer, kidney and bladder cancer, skin cancer, thyroid cancer, and breast cancer [17] even years or decades after exposure. The risk is proportional to the dose, and there is no known safe threshold (limit) any exposure may carry risk [13].
- **Genetic Mutations**: Radiation-induced DNA changes can be passed on to future generations if reproductive cells are affected since they are the carriers of genes [13].
- Other effects may include cataract formation and in some rare cases, cardiovascular disease can also happen [13].

2.4 Factors Influencing Effects

- **Level of Dosage**: Higher doses (either for short or prolonged time span), can significantly enhance the severity of effects. Chronic low-level exposure allows more time for cellular repair, reducing risk but not eliminating it [13].
- **Type of Radiation**: Alpha particles are highly damaging but do not penetrate far, beta and gamma rays penetrate deeper and can affect internal organs causing some serious health risks [13,16].
- **Tissue Sensitivity**: tissues like bone-marrow, gut lining, and reproductive organs which divide rapidly in the body are more sensitive to radiation [13].

  Foetus and adolescents are more sensitive and hence vulnerable to radiation than adults.

  Non-ionizing radiation does not have enough energy to ionize atoms or molecules. Its primary biological effect is heating tissues at very high intensities, but under normal environmental and occupational exposures, it is generally not harmful [13].

3. COMMON SOURCES OF RADIATION AROUND US

3.1 Natural Background Radiation

Human beings are exposed to certainly minimal or relatively negligible amounts or in some very distinct cases (at a place under special circumstances) very high dosage of natural radiation, every day from the ground, the air, and even from outer space. This is called background radiation. "Background radiation" refers to the ionizing radiation that is naturally present in our environment. We are constantly bathed in low levels of this type of radiation just by being alive on Earth and it's completely normal. This because the radiation from outer space of Universe, termed as cosmic radiation is mostly blocked by the magnetic field of earth. It is worth mentioning that the radiation from outer cosmos is highly energetic. It if would have not been resisted by the magnetic field of earth (as cosmic radiation is mostly charged particles) it would have even challenged the survival of human beings on earth. This is due to the fact that the highly energetic radiation may have impacted the cells (organs and human beings as a whole) leading to destruction of whole living creatures on earth. Research has mentioned about the levels of dosage of radiation in Ramsar City of Northern Iran at the nearby area of Caspian Sea as the highest natural background radiation level in the world [15].

- **Cosmic Radiation**

  Cosmic rays are **high-energy particles** that come from the sun and other stars **[21],** when they enter Earth's atmosphere, they produce **secondary radiation** that reaches the ground. The **cosmic radiation** increases with altitude. This means the people living in mountains or flying on airplanes get more exposure than those at sea level.

- **At sea level**: Nearly 0.06 μSv/h **[20]**
- **On a flight at 35,000 feet**: ~6 μSv/h **[20].** Therefore, the background radiation exposure decreases significantly at sea levels and happens vice-versa at high altitudes.
- **UV Radiation**: Primary source Ultraviolet radiation is the sun. Although Ultraviolet radiation is not considered a cosmic radiation. Since it's a low-energy radiation but prolonged exposure to UV is still very harmful to living tissues. It may cause sunburns, skin cancer, and cataracts [18]. One should note that the UV radiation exposure also increases with an increase in altitude when distance toward sun decreases.
- **Terrestrial Radiation**
  Terrestrial radiation refers to the natural radiation that comes from the Earth itself. It is naturally present in our environment in the air, water, and even the food. If the radioactive isotopes are present in large quantities, it could be unsafe. However, the trace levels are generally harmless. The Earth's crust contains naturally occurring radioactive elements. These elements release radiation slowly over time through a process called radioactive decay. This decay gives off ionizing radiation [23].
- **Average exposure:** ~0.3-1 mSv [22] (0.03-0.11 μSv/h) depending on soil and materials.
- **Radon Gas**
  Radon is a radioactive gas. It can seep into homes through cracks in the floor, walls, or in basements. It can increase the risk of lung cancer if inhaled over a long period. It forms when uranium in rocks and soil breaks down, it is obviously tasteless, odourless, and invisible, which is why it's important to test indoor air quality in some regions [24]. The annual global average per person dose from natural background radiation is 2.4 mSv [17,19].

3.2 Artificial Sources

- **Medical imaging**:
  In hospitals and dental clinics, medical imaging is a commonly used practice. Medical imaging techniques that use ionization radiation are X-rays, CT scans, and fluoroscopy. In healthcare, professionals practice them to examine bones, organs, and tissues. They assist in the diagnosis of a wide range of conditions by capturing how different tissues absorb or block radiation [24].
- **X-rays:**
  In medical field, the radiation is used to produce images of bones, chest, and teeth etc. X-rays have been used for that purpose. It is a form of electromagnetic radiation that is utilized often for the first-line imaging tool for diagnosing fractures, infections, or lung diseases. X-rays are recognized as an ionizing radiation. This process can sometimes cause genetic alteration within cells. Most of these changes do not result in cellular damage and do not lead to genetic mutations or health problems. However, it is sensible and recommended to keep radiation exposure as minimal as possible to minimize any potential **risks [25].**
- **CT scans (computed tomography):**
  It uses a series of X-ray images captured from various angles to generate detailed cross-sectional images of the body. CT scan is mostly effective for identifying internal injuries, cancers, and vascular diseases. However, it gives a higher radiation dosage compared to standard X-rays [27].
- **Fluoroscopy:** It provides real-time moving images, like an X-ray movie and it is widely used to assist diagnostics and procedures, such as cardiac catheterization, barium studies of the digestive tract, and placement of medical devices while performing surgeries. Fluoroscopy does involve continuous exposure to X-rays which can result in higher cumulative radiation doses, especially during lengthy procedures [28].
  These imaging techniques play a critical role in modern medicine. It gives us almost an accurate diagnosis used for guiding treatments. However, they are also the largest contributors to artificial

(man-made) radiation exposure in the general population, with CT scans and fluoroscopy accounting for the highest individual doses among imaging modalities.

According to the World Health Organization, "medical use of radiation accounts for 98% of the population dose contribution from all human-made sources, and represents 20% of the total population exposure. Annually worldwide, more than 4200 million diagnostic radiology examinations are performed **[29].**

3.3 Consumer products:

- **Microwave ovens:**
  Microwave ovens in homes provide a convenient way to cook and reheat food, which does so by producing microwaves. Microwaves are electromagnetic energy that has a frequency range from 300 MHz to 300 GHz meaning it is a kind of non-ionizing radiation, which is generally considered harm-less. However, very old models might lack some of the redundant safety interlocks or advanced shielding found in newer ovens. Exposure to very high levels of microwave radiation (far beyond what a properly functioning oven could leak) can cause thermal damage, leading to burns to the skin or, more critically, to sensitive areas with poor blood flow, such as the eyes (potentially leading to cataracts. Modern microwave ovens are designed with multiple safety features to contain the microwaves within the oven. While using a microwave it is best to take precautions [30].
- **Cell phones:**
  Phones are generally used every day for calls, scrolling, maps, alarms etc. Cell phones emit radiofrequency (RF) radiation, which is a type of non-ionizing electromagnetic radiation used to transmit signals between the device and nearby cell towers. Unlike ionizing radiation, the main biological effect of RF radiation is a slight heating of tissues near the phone, but this effect is minimal [31].
  In 2011, the International Agency for Research on Cancer (IARC), part of the WHO, classified RF radiation as "possibly carcinogenic to humans" (Group 2B) based on limited evidence for an increased risk of glioma, a type of brain cancer [32].
  The radiofrequency radiation level of a phone can be inspected by finding its Specific Absorption Rate (SAR) value. SAR measures the amount of RF energy the human body absorbs from the device on most Android and iOS devices, open the Phone app and dial *#07#. This will bring up a screen displaying your device's SAR or RF exposure information [33].
- **Cigarettes**:
  Cigarettes contain substances such as polonium-210 and lead-210 which are radioactive in nature. They are taken up from the soil and fertilizers by tobacco plants as they grow. When a cigarette is smoked, these substances are inhaled into the lungs, where they get accumulated over the time increasing the risk of lung cancer [34]. The presence of these radioactive elements is one of the many factors contributing to the high cancer risk associated with smoking [35,36].
- **Smoke detectors:**
  Many household smoke detectors use a minute amount of the radioactive element which is isotope Americium-241. This isotope emits alpha particles which ionize the air inside the smoke detector sensing chamber. When smoke enters the chamber, it disrupts the ionization process causing the triggering of the alarm. The amount of americium-241 used is very small and is securely contained, so the radiation exposure to users is minimal and considered safe for the public. The radiation dose to people in a home is extremely low less than what you receive from natural background radioactive radiation and poses no health threat as long as the detector is intact and not tampered with [37,38].
- **Luminous watches/Radium items:**
  Luminous watches historically used radioactive materials such as radium to make their dials glow in the dark. Radium is highly radioactive in nature i.e. 2.7 million times more than uranium **[39].**

While it is bright and has a long-lasting glow, it poses significant health risks. Even today, vintage watches with radium dials can produce radiation doses much higher than background levels, and keeping a collection of such watches in a small, unventilated space can elevate radon gas concentrations to hazardous levels. Old antiques and collectibles may contain radium [39,40].

- **Nuclear waste:**
  Nuclear waste is a by product from various nuclear activities, mainly from used or spent nuclear fuel from reactors in nuclear power plants which is classified as High-Level Waste (HLW) meaning it has high radioactivity, in medical facilities Radioactive materials used in diagnostics (e.g., PET scans) and cancer treatment (e.g., radiotherapy), In research facilities Materials used in scientific research, radioactive sources used in industrial Applications, and also in decommissioning i.e., Materials from dismantling nuclear facilities are all types of nuclear waste [41].
  The primary health hazard is the *potential* for accidental release of radioactive materials into the environment. The release of nuclear waste may result in human exposure by inhalation, ingestion (e.g., contaminated food or water), or direct external radiation.
  Under typical daily circumstances, direct contact with nuclear waste for the general populace is extremely uncommon and almost non-existent due to strict rules and regulations [42,43].

4. EVERY-DAY PRACTICES TO REDUCE RADIATION EXPOSURE

Radiation is ubiquitous in the environment but by adopting precautionary measures and making smart decisions, exposure can be minimized and hence overall radiation risks can be avoided. Generally, for an occupationally, exposed individual, 20 milli-Sievert/year or 2 rem/year,is said to be a maximum permissible limit which may not cause any noticeable or significant damage to cells or organs which could affect overall health of a person.

4.1 Spend Less Time around Radiation Sources

The first thing to remember is to minimize the duration of exposure i.e the lesser the time spent near a source of ionizing radiation, the lower the dose received. For instance, during an X-ray patients are exposed only for a brief period, while healthcare professionals step out of the room or stand behind a special screen to limit their exposure. The general public can reduce exposure by not hanging around places where radiation is actively used [44].

4.2 Keep Your Distance

Radiation gets weaker further away from the source. This means that even just by keeping distance from something like a microwave oven or a Wi-Fi router can lower the amount of radiation received [44].

4.3 Use Shielding

Sometimes, you can use something to block radiation. In hospitals, you might see lead aprons or thick glass windows in X-ray rooms. These materials stop most of the radiation from reaching you. At home, you probably don't need special shields, but if there were ever a radiation emergency, even staying inside a building, closing windows and doors, and staying away from outside walls can provide an effective and much needed protection [44].

4.4 Be Careful with Medical Tests

Medical tests such as X-rays and CT scans are great for diagnostic purposes but they do include the use of radiation. These tests should only be conducted when deemed necessary by your physician. If you have concerns, you can ask your doctor if there is another way to check your health, such as ultrasound or MRI, which don't use radiation [45].

It is a good idea to keep a record of your history of radiation exposure, such as previous scans and other types of X-rays, so that you can inform your doctor [28].

4.5 Use Phones and Electronics Wisely

Cell phones and Wi-Fi devices are not much harmful to human health. However, it is best advised to be extra cautious, there are simple steps one can take to further reduce exposure.

- **Use Speakerphone or Earphones:**
- When making calls, use a wired or wireless headset. This keeps the phone away from your head and reduces the amount of radiofrequency exposure [45].
- **Avoid Sleeping with Your Phone Near Your Head:**
- Not sleeping with phone (charging or not) under the pillow or right next to your head. Devices should be placed on a table or across the room [45].
- **Limit Device Contact with Your Body:** Avoid keeping your phone pressed against your body for long periods, such as in your pocket or on your lap [45].
- **Reduce Call Duration:** Keep phone calls short, text instead of calling if possible, to minimize exposure [45].
- **Shadow zones:** Cell towers send out signals in all directions, however, there are areas called "shadow zones". In these zones the signal is weaker or blocked by buildings, hills, or other obstacles. In these zones, your phone may work harder to connect, increasing its radiation output. If you are in a place with poor reception (like a basement or behind thick walls), your phone increases its power to maintain a connection, which can raise your exposure. Try to make calls or use data in areas with strong signal bars [46].

4.6 Don't Touch Old Glowing Items

In the past, some watches, clocks, and toys that glowed in the dark, which may be due to many reasons (like fluorescent materials etc.) were manufactured using radioactive materials like radium. These are not sold anymore, but can still be found in any arbitrary or antique shops or in old family belongings. Don't open them, break them, or let children play with them. One must take the help or advice of local concerned authorities for the safe disposal of any such items [39].

4.7 Precautions for Microwave Oven Use:

• Inspection should be conducted to maintain its integrity. Usage must be avoided if any component is damaged, as this may result in severe radiation leakage.

• Only use microwave-safe cookware and materials. Avoid all metallic things, including foil, as they might produce electrical sparks which can cause harm to the device.

• To avoid damaging internal components, do not use the microwave when it's empty.

• Do not attempt to fix or tamper with the oven's safety features or internal components on your own. Go to a qualified technician [47,48].

4.8 Healthy Diet and Good Hygiene

Some food groups with proper checklist can help **reduce the risk from radioactive** contamination which could support the body's natural recovery processes, if one gets anyhow exposed under any certain conditions or unfortunate circumstances due to sheer ignorance:

- **Iodine** rich food prevents the body from absorbing radioactive iodine.
- **Pectin-rich** foods like apples and citrus fruits, as well as sulphur-rich veggies like broccoli and cabbage, can aid in the body's removal of radioactive chemicals.
- A well-balanced diet containing antioxidants and nutrients aids the body's repair and health maintenance following low-level radiation exposure [49,50].

On average, our radiation exposure due to all natural sources amounts to about 3 mSv a year - though this figure can vary (Radiation in Everyday life by IAEA) While certain forms of radiation can indeed be harmful in high doses, it's important to recognize that not all radiation is dangerous. Much of the exposure we experience daily is at very low levels and is generally harmless. In fact, some radiation is even used beneficially in medicine and industry.

5. SUMMARY AND OUTLOOK

Background Radiation, i.e., a precariously pre-existing radiation, which is present all around us, in our environment can be classified into various forms. On basis of available studies, we showcased that some sorts of radiation gets originated from the natural sources and some from the artificial or man-made sources. Radiation can be broadly classified into two classes, ionizing or non-ionizing. Ionizing radiation carries sufficient energy to disrupt atomic structures and can further damage the DNA in living beings, thereby elevating the risk of cancer and genetic mutations. Non-ionizing radiation, being less energetic is considered less hazardous however, excessive exposure can cause significant health concerns for instance skin burns or long-term tissue damage.

Individuals, in general, get certainly exposed to a meagre level of radiation from all around on a daily basis. But this may not lead to any immediate health risks. However, chronic or high-level exposure particularly due to ionizing radiation can result in acute conditions e.g., skin burns, radiation sickness and amplify the probability of future health complications. Children and foetuses are especially vulnerable due to their developing tissues.

Every household contains at least one item that is an artificial source of radiation such as cell phones, microwave ovens, etc. Even certain medical procedures require the use of radiation. All such may contribute toward an individual's cumulative exposure. While the health risks associated are minimal, still carefulness is advisable. One can take steps to ensure some immunity, or must limit unnecessary medical imaging or any kind of exposure by maintaining appropriate distance from active sources shielding your-self on a precautionary note. Handling older radioactive items responsibly can further reduce exposure. Furthermore it is advisable to maintain a balanced diet which may support the body's recovery from any major or minor radiation exposure.

In the future, there's a strong possibility that AI will be integrated with radiation detection systems to enable real-time, personalized monitoring. For instance, dosimeters could become wearable like a watch, and provide instant alerts when an individual enters an area with a high dosage rate, in medical imaging, with the development of AI deep learning new technologies are being developed which focuses on reducing this dose while improving image quality which could lead to a significant reduction in patient exposure, especially for those who require frequent scans, and smart sensors can be set up in buildings or ventilation systems that can continuously monitor for radon gas or other radioactive contaminants. AI algorithms can also help distinguish between different types of background radiation with striking accuracy. A global network could be established to monitor and collect data from sensors placed in the soil, air, and water, all integrated into a single platform. This would allow for the real-time tracking of both natural and human-made radiation events, enabling a quicker response to any potential hazards.

As technology makes radiation measurement more accessible, public awareness will grow. While this will empower individuals to take charge of their safety, it may also lead to unnecessary fear or misinformation.

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