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Review of Previous Studies on Radon Gas Concentrations in Air in The World

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ABSTRACT:
Radon is a chemically inert gas that is radioactive and has substantial impacts on human life. It is found in various levels in soil plus different sources of water and air. In spite of having a short half-life, radon has greater threats to the environment and health as well. Humans used soil for agricultural activities, construction of houses and permitting water to flow through valleys at the same time we do not have adequate knowledge about the dangers of radon — more research because it is one of the major causes for (different) diseases like cancers such as stomach cancer and lung cancer. In this review revealed some studies using several data related to measuring radon concentration in soil in Iraq for many governorates during (2003-2023) with a solid-state nuclear trace detector; this provides higher measurement accuracy. Recent research has found that the average radon levels in Norway are high - above the world air standard value (400 Bq/m^3). In each province, several factors make airborne radon concentrations increase or decrease, based on whether or not the nature of the terrain is suitable, and those are discussed and elaborated on in this report.

KEYWORD: *Radon concentrations, Air, and solid-state nuclear trace detector*

I. INTRODUCTION

Radon is a naturally occurring radioactive gas discovered in the 20th century. Dawn in the 20th century. It is an uncoloured natural creature. Radon is a water-soluble, odourless gas. Three natural analogs are derived from three different compounds. The radioactive decay chain begins at ^{238}U. ^{232}Th and ^{235}U[1]. Is the most common search term for^{222}Rn.Radon 220 (t1/2=56 seconds) known as thoron gas222Rn, is most common analogue of radon that has to be searched together with information from porous materials also having similar activity levels for non-porous materials; this means that Thoron Gas has a much shorter half-life and its concentration in the body is relatively low Air in the second sense The third isotope, radon-219 (t1/2 = 3.92 s), called actinium which has been shown to exist in the decay series of actinium (^{235}U) [2]. Radon is an unstable radionuclide that decays through a series of short-term decays ultimately forming stable lead Short-lived radon decay products are responsible for this [3, 4]. The human body can mainly inhale and absorb radon gas in two ways. One is through breathing, and the other is through drinking water, other types of fruits and vegetables, and bathing [5,6]. According to U.S. EPA (200-400) Bq/m^3 as a maximum level for radon in the air. In the uranium decay series one of the precursors ^{222}Rn has a half-life that can be measured at about 3.82 days emitting alpha particles while turning into ^{218}Po ($t_{1/2}$ = 3.11 m) which reaches however ^{210}Pb it will keep falling out until it reaches equilibrium with its parent [7, 8] In this paper several points I would like to denote. Different techniques used for assessing concentrations of Radon in residential air in some provinces of Iraq.

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Authors: Researchers collect data and compare results to plan future work and plans. In addition, there is a risk of radon gas inhalation indoors. Since air is vital for life be restrictions should be applied to protect humans from dangerous radon and other radionuclides [9, 10].

II. Review previous studies

Table 1 presents information on radon concentration data obtained from earlier studies for different homes in different ways and different countries. Radon happens to be the second most common cause of lung cancer after tobacco smoking

1. **Table 1** tabulation was prepared to compare different country.
of concentrations of radon (^{222}Rn) from periods between 2003 and 2023.

No.	Location	Average ^{222}Rn Bq/m^3	year	Ref.No.
1	Brazil	40	2003	[11]
2	Tunisia	40	2004	[12]
3	Saudi Arabia	22 ± 15	2005	[13]
4	Span	69.5	2007	[14]
5	Jordon	44.1	2008	[15]
6	Pakistan	70.67	2010	[16]
7	Norway	1000	2011	[17]
8	France	53	2013	[18]
9	India	40	2014	[19]
10	Turkey	57	2015	[20]
11	Iran	57.6 ± 33.06	2016	[21]
12	Canada	126	2017	[22]
13	Indonesia	24	2019	[23]
14	Navajo Nation	60.5	2020	[24]
15	China	54.6	2021	[25]
16	Iraq	63.391±22.73	2022	[26]
17	Columbia	21.96 ± 3.16	2023	[27]

The survey comprised Brazil. The average radon concentration in homes is 40 Bq/m^3. The data inform on EEC behavior of radon Outdoor radon gas concentrations inside buildings in Brazil are affected by environmental and tropical conditions, as well as geological and climatic aspects, and this has been clearly observed. [11].

Indoor air radon concentrations are not known in Tunisia. It has been realized for the first time in several regions of this country by means of Open beakers that measure the effects of alpha particles and which contain the cellulose nitrate reagent LR-115. Sixty-nine dwellings About Greater Tunis were distributed through one year, the dosimeters was changed every two month; another 12 locations were put during two winter seasons. Average of 1217 measurements was 40 Bq/m^{3}and 93.4% <100 Bq/m^3; It was the highest concentration equal to 392 Bq/m^3. In Tunis, concentrations were measured to be high in winter and decreased in summer because less ventilation is observed when it is cold. In addition, indoor radon concentrations in the air change depending on the geographical location and values reached up to tenth milligram percentages In some government areas in Tataouine, Beja, Jendouba and Gafsa, there are lead and phosphate elements mine/deposit exists. The first study found In Tunisia, levels of indoor radon gas concentrations were low. However, further studies should be made in specific Fields: Building materials, climate change, and geology must be taken into consideration[12].

The survey covered In the Kingdom of Saudi Arabia, specifically in the Qatif region, where 225 detectors were installed. Average of radon concentration in homes was 22 Bq/m^3 However, one of homes revealed an

anomalous radon concentration of 535 Bq/m^3. Therefore, a follow-up detailed investigation for this dwelling was carried out using active and passive techniques [13].

In the period from 2001 to 2003, a cross-sectional study was conducted to measure the rate of radiation contamination, where 983 homes were audited from the same number of individuals who were randomly selected from the 1991 census. Samples were taken for the same area, which was divided into groups and classes according to the population density in the areas, which affects the rise in radon concentrations. And the different housing characteristics in each selected house. Multivariate and Bivariate analyzes were calculated to investigate the factors affecting radon concentration .Geometric mean radon concentration was 69.5 Bq/m^3, with a 21.3% prevalence of >148 Bq/m^3 in homes. The reasons for the increase in these concentrations were as follows: external building materials, internal building materials, the age of the dwelling, and the floor on which the detector is located, distance off floor, and number of storeys; for example, if a variable is not significant in final multivariable modeling but significantly associated with radon concentrations at a final uncertainty level or vice versa (low no significant value), it should be included while others are excluded .Ageing dwellings have high levels because they are more cracked than newer ones; hence, cracks can introduce more transport pathways into buildings that let more gas accumulate inside them during construction or use materials that can contribute sources (e.g., granites rich with uranium). The model was important but was 10% of explained variability. Thus, these results confirm what was obtained for the study area considered high radon emission and that other factors not directly related to the characteristics of the dwelling influence the concentration of radon [14].

The average indoor radon concentration in the Hawar and Al Foah areas is 44 and 34 Bq/m^3, respectively. From these results, there are no clear differences between the two villages regarding radon concentrations[15].

The indoor air samples were collected from closed rooms in dwellings in Pakistan over a period of 2 days with a continuous protocol and auto mode of the instrument with a special attachment for the specific purpose of measurement by the RAD-7 detector for radon content in air. High-performance continuous radon measuring equipment used was RAD-7 detector. Samples were collected according to the Environmental Protection Agency (EPA) protocol [16].

The reason for making closed homes is that in the winter, when the climate is cold, most people close the windows and doors, which leads to a high level of radon gas concentration, exposing residents to radon gas and its offspring. The indoor air radon concentration was measured against the radon resistance of the radon barrier in a selected group Radon concentration values in the ground, number of air changes per hour, building Volume/ area to floor ratio, air permeability to floor and air pressure difference between the external and internal ground at ground level percentage was as highas 100.000 Bq/m^3 with mean concentration are 1000 Bq/m^3 [17].

The geometric mean RC was 53.0 Bq/m^3. At this concentration, the percentage that exceeded 100 Bq/m^3 was 22.8%, and that which exceeded 400 Bq/m^3 was 2.4%. The spatial distribution of the measurement points covers most parts of France, although for some regions results are either very few or lacking. In general, Hercynian granitic rocks were higher radon concentrations were observed [18] .

Research carried out on indoor air within the building in Shiraz city in 2015. In this study, GIS software technology was used. GIS software and spatial sampling devices were chosen with an area of 25 km^2 and 200 points. Passive diffusion sampling technology such as SSNTD CR-39 polycarbonate films was used in the winter for three months. sampling was carried out as recommended by US EPA protocol. We have analyzed twelve elements so Building material samples from Kurukshetra University, Kurukshetra (India) were procured for radon and thoron determination following the twin cup dosimeters technique along with radon emanation from soil sources below them. Dosimeters were fabricated using property materials mentioned earlier adopted uniform scientific procedures either than measuring against calibration factors To different depths. Thoron

measurements ranged from 9 to 73 Bq/m^3 as for concentrations radon ranges from 17 to 51 Bq/m^3 in homes, and measurements of radon in soil ranged from 2.80 kBq/m^3 to 6.46 kBq/m^3 [19].

The results were obtained from 153 residential areas in 81 provinces in Turkey (7293 dwellings) and corrected for average seasonal variations. The concentration of indoor radon ranges from 1 to 1400 Bq/ m^3. An arithmetic mean of annual radon concentrations is 81 Bq/ m^3; the geometric mean is 57 Bq /m^3 with a geometric standard deviation of 2.3 [20].

Radon levels at the time of sampling and calibration factors were calculated. Using IBM-SPSS, version 20, descriptive statistics, Kruskal-Wallis tests, and Mann-Whitnium tests, the data were analyzed. The result of the measurements was an average radon concentration of 57.6 Bq/m^3 in homes. The average effective dose is 1.45 mSv/year. In 5.4% of houses, the presence of radon exceeded 100 Bq/m^3; this is higher than the world health organization (WHO) [21].

A test was conducted to measure radon concentrations inside Calgary homes and surrounding areas. There were 2,382 residential homes (2,018 inside Calgary and 364 in surrounding towns), 82% of the population of southern Alberta. These measurements were in accordance with Health Canada guidelines for a period of ninety days Information about the houses was taken from (type of foundation, year of construction, type of building, floor, and type of rooms). The measurements were repeated after a period of renovating the houses to determine the effectiveness of applying the conditions for reducing the concentration of radon levels. The average level of radon in the indoor air was 126 Bq/m^3, which is Equivalent to 3.2 mSv/y effective absorbed radiation dose. Homes built in 1992 and later were noted , levels were 31.5% higher on average compared to older homes (average 142 Bq/m^3 to. 108 Bq/m^3). The average radon level was 575 Bq/m^3 in ninety homes before treating the high radon levels, and the treatment succeeded in reducing them to 32.5 Bq/m^3 successfully [22].

Analysis revealed radon levels in South Kalimantan to be within the range of 3.1 Bq /m^3 to 94.0 Bq/ m^3 with a mean concentration of 24 Bq /m^3. Thus, these values are below the recommended radon concentration by UNSCEAR of 300 Bq /m^3. The result were showed, data for producing radon maps in South Kalimantan Province; this served as part of the map of radon for all Indonesia [23].

Both a home and an indoor radon survey were carried out with volunteers who reported residence on the Navajo Nation. It recorded home geolocation, structural characteristics, temperature (◦C) during radon testing, and elevation (meters). Measurement of short-term indoor radon kits was another activity. They measured 51 homes for indoor radon levels, with an arithmetic mean concentration of 60.5 Bq /m^3 [24].

This paper revealed China's indoor radon exposure from 2000 to 2020, with a focus on Colder seasons and severe cold areas, related to the mean concentration of indoor radon for dwellings being 54.6 Bq/m3. Newly decorated buildings that were closed by window and door also had higher indoor radon level. The independent t-test found that many demographic features such as climate region are related statistically to ventilation ($P<0.004$). Climatic conditions and ventilation factors were of great importance in determining the relationship between the increasing indoor radon concentration in China during the previous two decades; It is supposed to measure more than one measurement of indoor radon concentration in offices and schools to more accurately analyze the causes of lung cancer in China. A statistical analysis was conducted in conjunction with housing characteristics of the indoor radon level in rooms with different ventilation and other climates [25].
In Dhi Qar Governorate, Iraq, radon gas levels were measured using CR-39 solid nuclear track detectors in 65 closed-room homes for a period of 2 months. The measurements indicated a noticeable difference in concentration rates, as the lowest concentration reached 20.805 Bq/m^3 in teachers and the highest concentration was 114.431 Bq/m^3 in the flame at a rate of 63.391±22.73 Bq/m^3 [26].

In the province of Balikesir the main topical of study to quantify radon gas levels within the campus of Balikesir Universities Health Vocational School and Research Hospital and the Faculty of Medicine. Moreover, that study tries to find out the risk potential of lung cancer due to the concentrations of radon that is measured. For this purpose, radon monitoring running for 2–3 months on a large scale was carried out by placing detector Columbia Resin-39 (CR-39) at 28 different places. The primary goal of these measurements was to ensure a comprehensive assessment of health hazards for both employees and students and appropriate actions in this respect. The smallest value obtained from the measured concentration of radon gas is 6 Bq/m^3 , while the highest measured value is 60 Bq/m^3 . The average measurement value is 21.96 Bq/m^3 . Results were below the permissible value on radon activity concentration in the norms "Radiation Safety Directive[27]." This confirmed compliance with permissible levels.

III. Discussion

Air is life essential. Air without life, Life does not make sense because Breathing is dependent on it for us humans as well as the food manufacturing process by plants. The health effect from may present some risk values such as causes cancer different form. Cancer risks due to exposure high levels above normal value standard concentration set when greater than its impact so bad especially on children or aged people who lives damage for long time sometimes country economy make The all developed countries are controlling level of radioactivity but developing countries do not know about this In regard that a knowledge The control measure Country " have established research has been conducted many countries (2003 - 2023) to measure concept... In certain countries, radon concentrations vary at the region scale For any reason, any region is different terms of geological structure and rocks. This review is substantial in the turn of education for Effects of traces of radioactive elements, including radon gas in the air, and diseases and how to prevent them[9]. Radon measurements in some countries were recorded to be higher than the recommended value (Brazil, Tunisia, Saudi Arabia, Spain, Jordan, Pakistan, Norway, France, India, Turkey, Iran). Canada Indonesia Navajo China Iraq Balikesir.

Table No. (1) also gives the concentration of radon gas i at any location in these countries. The study area is below the recommended value. In this review, high mean concentration of radon gas in Norway reached (1000 Bq/m3), which is above what is declared to be the average value because it has rich granite rocks and geological formations. Radon (^{222}Rn) is an important isotope because it can change to an atom (^{218}PO) and keep decaying t form into another one is Different because of its danger and bad effect on the human body and other organisms. Radon, especially the main effect that causes cancer, some people in the radioactive area believe that radon has more effects on the human body and is clearly fatal in the lung, causing chronic interstitial fibrosis, and it has the same effect appear of our skin also cause malignant skin cancer. That radon can cause cancer in the human body and then the World Health Organization supported it and introduced it through carcinogens. But note The reason is likely that most people do not have sufficient knowledge about radon, its sources and health effects, even in most countries, especially developed ones, air pollution cannot be viewed As a major dilemma between countries. There is another solution such as reducing the population of the radioactive area disseminating increased knowledge about radiation because it is a general The dilemma is that a radon reduction program has been an important treatment. Where ETA is a responsible and accountable water quality organization for this drinking water problem, and at the same time the employee educates people about it and gives them information about it because this problem concerns the general public. In many measured data, the matter differs with the date. On a snow day, the temperature goes down because on a snow day radon activity goes up. Radon causes cancer but there are mistakes around it; many of them think that radon gas causes headaches, and other confusions with the Carbon monoxide sign Headache is their main sign. Therefore, knowing radon gas is the main reason for treatment, and it may remain in the future. We need a huge amount of research and many studies to raise awareness and reduce the impact of radon on humanity because it is a general problem in any country in which it is present (different dose). No one can neglect the impact of radon..

IV. Conclusions

The study discussed in this article aimed to provide a comprehensive review and analysis of airborne radon concentrations from a global perspective. The study examined radon studies conducted around the world to understand the characteristics of radon concentrations in homes. The study sought to use data from a global review to demonstrate the association between indoor radon exposure and lung cancer incidence. The study found that exposure to dangerous radon gas requires three factors: abundant geological sources and pathways of radon gas, environmental design indicators that actively capture and concentrate radon gas, and substantial or voluntary human efforts to extend exposure or increase radon gas concentrations. Behavior. The latter two variables (environmental design indicators and human behavior) may be modifiable and of interest in reducing exposure. Historically, it was thought that radon exposure increased in colder climates where people spend much of the year indoors. However, analysis of the modern built environment is critical to understanding exposure to many carcinogens, especially in the context of climate change and the increasing adoption of air conditioning in various regions, which may change this 20th century norm. The study also highlights areas for future research to better understand home radon concentrations, indoor radon exposure and their impact on lung cancer incidence.

V. References

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