Evaluation of radon gas concentrations in residential air within the Al-Qadisiyah district, Baghdad, Iraq

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Abstract. The study aimed to assess the concentrations of radon gas in residential areas of the Al-Qadisiyah district in Baghdad, Iraq.Radon levels were determined in the bedrooms, living rooms, and kitchens of multiple homes located in the community. On average, the concentration of radon detected in the bedrooms measured 38.795 ±3.873Bq/m3, while the amounts identified within the living rooms and kitchens varied between 45.77 ±3.214 and 54.695 ±16.637 Bq/m3. The conclusions uncovered that the majority of radon concentrations were under the limits established by the World Health Organization, indicating the radon exposures in these dwellings posed minimal threat.

1 Introduction

Natural sources constitute the principal contributors to the radiation dose encountered by humans daily. An estimated 86% of overall human radiation exposure derives from natural sources, with more than half directly associated with the absorption of radon as its decay byproducts in enclosed indoor settings, including homes and workplaces. Three naturally occurring radon isotopes exist - Radon-219, Radon-222 – and Radon-220, each connected with a distinct radioactive decay series involving uranium-235, uranium-232, and uranium-238. Radon gas, a colorless, odorless, and radioactive element and tasteless noble, was identified in 1900 by German physicist Friedrich Ernst Dorn [1-2]. It forms as a result of radium decay in soil, water, and construction materials. For instance, radon-222 - ranking third among alkali metals with a half-life of approximately four days - makes up 99% of all radon and decays from radium. However, the most consequential of the three radon isotopes from a health perspective is radon-222 due to its greater indoor air concentration and the risks posed by its decaying daughter products.The radioactive daughter isotopes of radon-222 include heavy metals like polonium, lead, and bismuth that are produced through its breakdown. Readily absorbing onto airborne particles, these radionuclides can easily enter

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the body through inhalation or ingestion and potentially impact one's health. Indoor radon pollution is particularly prevalent in poorly ventilated indoor locations where concentrations exceed outdoor levels [3]. Prolonged exposure to high indoor radon concentrations has been directly associated with an elevated risk of lung cancer for the general population. Radon, a radioactive gas that occurs naturally and is represented by the chemical symbol Rn as well as atomic number 86, demonstrates polymorphism, indicating the presence of other radon isotopes, notably 222Rn, which has a half-life of around 3.8 days. Radon-222 is produced from the decay of radium-226, which originates from the decay of uranium-238, and is the primary gas released through the transmutation of uranium, thorium, with actinium. Radon-222 and its progeny substantially irradiate people, increasing the risk of lung cancer [4]. increase the possibility of pulmonary carcinoid The interaction for positron-emitting alpha particles by radon with pulmonary tissue during respiration might cause DNA damage and increase the risk of lung cancer, depending on radon concentration and duration of exposure [5]. According to a research by the American Environmental Protection Agency, Radon is a second leading reason for lung cancer after smoking. Radium-226 (226Ra) is a prevalent radioactive element located in the Earth's crust, notably in rocks and stones and soil, produces radon gas. Certain construction materials contain terrestrial and lithic components encompassing 226Ra which generate radon. Radon typically originates belowground It can penetrate residences via cracks in the walls, basements and and foundations. It can also penetrate homes through tap water, including when use the sink in the kitchen and shower. Considering which radon exists as a natural gas, completely eliminating trace levels in the atmosphere is impractical. Nevertheless, most radon exposure derives from remaining indoors. Numerous investigations have demonstrated that both Smoking cigarettes and radon may can independently harm or that the risk is substantially amplified when exposed to both jointly [6, 7]

2 Study area

Al-Qadisiyah is a residential neighborhood in the Iraqi capital, Baghdad. It is distinguished by its geographical location in the Karkh district, west concerning the Tigris River. It is delineated to the northeast by the Mansour area, to the south with the Yarmouk neighborhood, and to its east by the Tigris River, and to the west by the Al-Amiriya neighborhood.The region is characterized by a diversity of building styles, including multi-story residential and commercial structures. The area is considered a medium-to-high population density neighborhood. It faces some environmental challenges, such as a lack of green spaces and high levels of pollution.

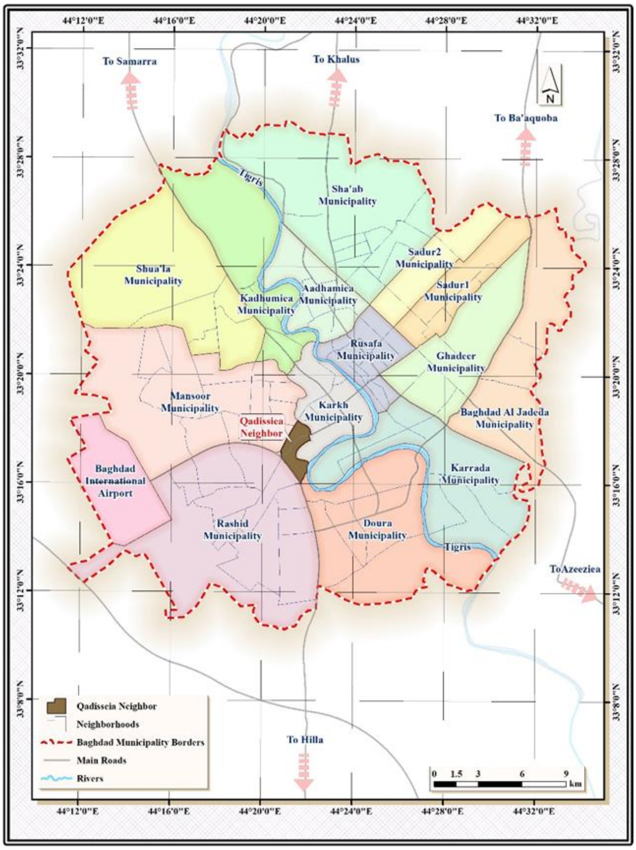

Fig. 1. Map of Baghdad showing Al-Qadisiyah neighborhood (study area).

3 Practical part

Radon concentrations were assessed in 20 residences in Al-Qadisiyah District. Each home (living room, bedroom, and kitchen) was measured using an Airthings 2930 Wave Plus. The device was positioned in each assessed region of the domicile for a period of 24 hours. The Airthings 2930 Wave Plus is designed to evaluate indoor air quality, including radon levels. This apparatus quantifies radon via a sensor that identifies it through ionization. Radon gas undergoes radioactive decay, releasing alpha particles. The device's sensor detects these particles to quantify the concentration of radon throughout the atmosphere. Ongoing Monitoring The device consistently monitors radon concentrations and provides data on temporal fluctuations of radon levels. This lets users to understand the variation in radon levels in various areas of their house or building. At times levels were higher, other times they decreased, showing the dynamic nature of radon concentrations.Radon Measure UnitThe device typically demonstrates radon concentrations in Picocuries / liter (pCi/L) and Becquerels / cubic meter (Bq/m³) are the most common units for measuring radioactivity levels within the atmosphere.These scientific metrics allow for meaningful analysis of radon danger.Battery-Powered and WirelessThe Airthings 2930 Wave Plus is battery-powered and may interface with the Airthings application by Bluetooth, facilitating quick monitoring and retrieval of past data. By providing continuous monitoring with real-time notifications, it assists users in maintaining safe home air quality by mitigating excessive radon exposure.

Alerts were intermittently activated when levels surged, indicating possible health hazards [8, 9].

Fig. 2. Airthings Wave Plus radioactivity detector.

4 Results and discussion

Table 1 presents the findings of radon gas concentrations within residences located in the Al-Qadisiyah area of Baghdad, Iraq. Radon concentrations were measured in each home for the bedroom, living room, and kitchen. The averages for the bedroom 62.5 Bq/m³, living room 60.2 Bq/m³, and kitchen 65.0 Bq/m³. The majority of the results fell beneath the limit determined by the (World Health Organization). The concentration of radon within homes can differ greatly due to numerous aspects, which together ascertain how much of the radioactive gas builds up indoors. Radon is naturally created through the decay of uranium, thorium, and radium embedded in rocks and soil beneath our feet. Geological elements significantly impact radon levels, as certain rock and soil types containing higher quantities of uranium and radium like granite, shale, and phosphate rock lead to elevated radon concentrations in areas with these formations underground, meaning dwellings in such locales are more likely to possess heightened radon amounts [10]. Another pivotal element is the architecture and building practices employed. Houses with cellars or built straight into the earth are more vulnerable to radon seepage, particularly if cracks or gaps exist in the foundation. Moreover, structures that lack proper airflow or are tightly sealed can trap radon inside, allowing the gas to accumulate over extended periods. Homes outfitted with improved ventilation mechanisms or radon mitigation techniques such as exhaust fans are better equipped to minimize indoor radon levels

Table 1. Concentrations of radon gas in residential properties the Al-Qadisiyah neighborhood in Baghdad, Iraq.

Home No.	Bedroom (Bq/m³)	Living Room (Bq/m³)	Kitchen (Bq/m³)
1	30.3	57.5	42.8
2	22.1	39.7	64.3
3	51.5	29.3	54.2
4	38.7	42.1	61.9
5	40.3	53.2	62.7
6	15.2	33.8	67.4
7	47.9	35.4	73.2
8	16.4	54.5	58.0
9	23.8	63.2	68.5
10	62.0	70.1	75.9

Continuation of Table 1.

Home No.	Bedroom (Bq/m³)	Living Room (Bq/m³)	Kitchen (Bq/m³)
11	34.5	72.3	47.6
12	25.9	38.0	72.9
13	50.6	59.2	44.1
14	68.3	36.0	61.0
15	64.8	48.7	44.0
16	25.2	33.1	38.2
17	67.7	55.4	19.9
18	14.4	22.0	66.3
19	31.3	48.9	43.2
20	45.0	23.0	27.8
Average Radon Levels	38.795 ±3.873Bq/m³	45.77 ±3.214 Bq/m³	54.695 ±16.637 Bq/m³

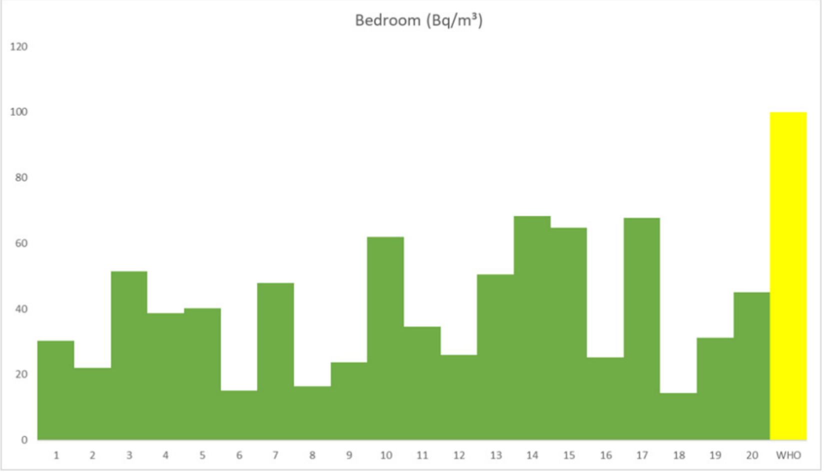

Fig. 3. Comparison of the outcomes of radon gas testing in theair of the houses of Al-Qadisiyah neighborhood (bedrooms) with the safe limit.

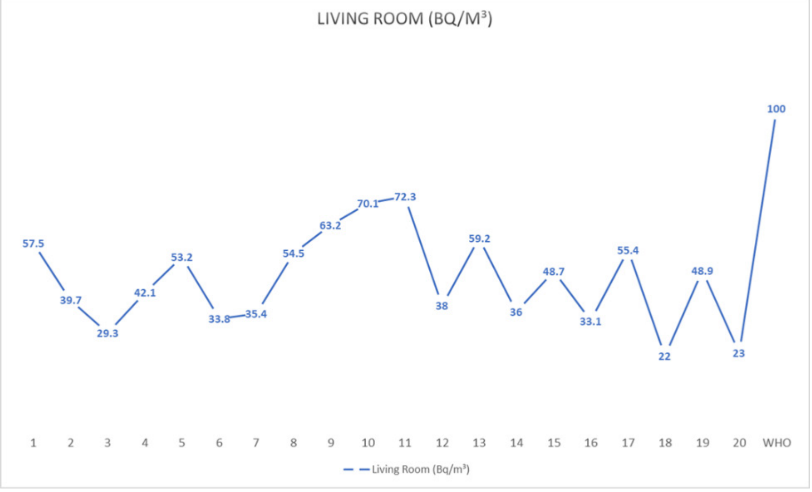

Fig. 4. Comparison of the outcomes of radon gas testing in the air of the houses of Al-Qadisiyah neighborhood (Living Room (Bq/m³)) with the safe limit.

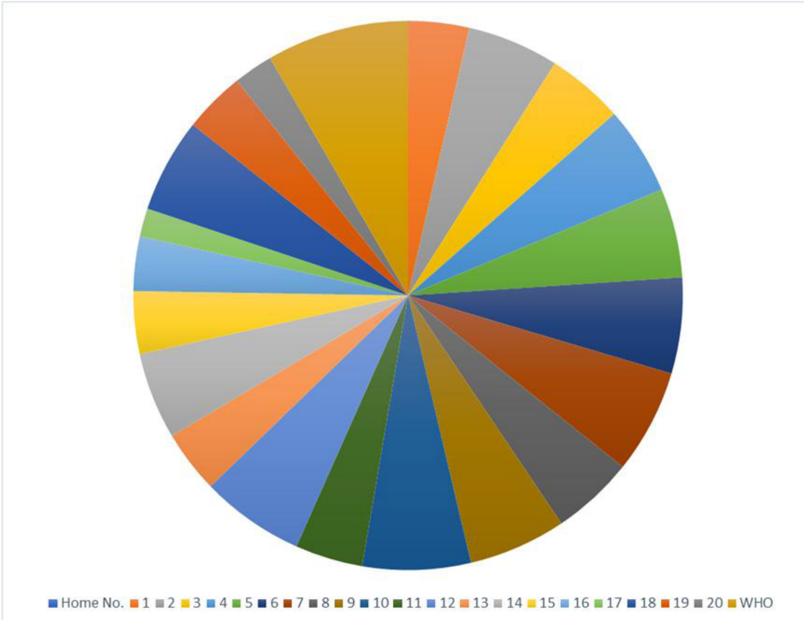

Fig. 5. Comparison of the outcomes of radon gas testing in thethe air of the houses of Al-Qadisiyah neighborhood (Kitchen (Bq/m³))) with the safe limit.

5 Conclusion

The findings from the research study titled "Assessment of Radon Gas in the Air of Houses in the Al-Qadisiyah District, Baghdad, Iraq" uncovered important insights about radon gas concentrations found within residential areas. The results demonstrate that while most homes had radon levels below the recommended criteria set bythe (World Health Organization), the potential health implications warranted further examination. Specifically, the study revealed that radon concentrations measured in the air of houses in the Al-Qadisiyah district were typically under the limits suggested by WHO as posing immediate concern. However, prolonged exposure to even marginally elevated radon, no matter how slight, cannot be dismissed as potentially posing risk in the long run. As such, continued surveillance and enhancing public awareness regarding radon is advisable though no immediate interventions seem necessary based on the current data. The findings highlight the value of ongoing monitoring to better understand radon dynamics and impacts on community health over the fullness of time.

Resources

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