GAS Journal of Clinical Medicine and Medical Research (GASJCMMR)

Volume 2, Issue 9, 2025 Journal Homepage: https://gaspublishers.com/gasjcmmr/ ISSN: 3049-1568
Email: gaspublishers@gmail.com

Monitoring of Radon Gas in Air and Water of Iraq: A Review

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Received: *20.08.2025* | ***Accepted:*** *18.09.2025* | ***Published:*** *20.09.2025*

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DOI: *10.5281/zenodo.17166823*

Abstract **Review Article**

Radon-222 (222Rn) is a natural radioactive gas with known carcinogenic effects. Iraq's distinct geology and issues associated with infrastructure account for differences in radon levels between the regions. The review also consolidates evidence from 15 academic and institutional sources on radon concentrations indoors, contamination in water, health effects and approaches to mitigation. Conclusions this study shows that an overall high level of radon exposure exists in different provinces in Iraq, especially within ill-ventilated buildings and sources of water. Based on this study, national radon mapping, public information and regulation enforcement are indicated.

Keywords: radon, Iraq, indoor air quality, groundwater contamination, radiation dose, public health.

1. INTRODUCTION

^{222}Rn is a naturally-occurring, radioactive noble gas that formed from the decay of uranium-238 in soil and rock. It is colorless, odorless and tasteless to detect without special equipment. Internationally, among non-smokers radon is the second most prominent cause of lung cancer (after smoking) (WHO, 2009). It is also geologically characterized by the existence of uranium bearing formations, sedimentary basins and fault zones easing its high potential for accumulation in indoor environments and water sources (Al-Timimi & Al-Kazwini, 2019; UNSCEAR, 2000). Researches in Baghdad, Basrah and Southern part of Iraq showed a high concentrations of radon in comparison with the world radiological safety level especially inside poorly ventilation building and ground water source (Al-Kinani et al., 2020; Hassan et al., 2021). Notwithstanding these findings, public knowledge is low and legal enforcement is scarce, showing clearly the necessity of national radon mapping strategies and mitigation systems (Ministry of Environment Iraq, 2015).

2. INDOOR RADON CONCENTRATIONS

Indoor radon concentration in Baghdad varied from 5.77 to 23.27 Bq/m³ and was maximum value in kitchen (Al-Kinani et al., 2020). In a southern Iraq (heritage) structure, CR-39 long-time detectors indicated two levels of radon concentration as high as an average 80,717 Bq/m³ which exceeds any global limit of safety requirements (Al-Mousawi & Al-Janabi, 2018). Studies in Karbala and Najaf reported high radon concentrations inside schools and hospitals, with annual effective doses close to 1 mSv/year (Al-Khafaji & Al-Samarrai, 2020; Al-Saadi & Al-Taie, 2016).

3. RADON IN WATER SOURCES

Radon activity concentrations in groundwater samples collected from Basrah and Kirkuk ranges between 0.18 and 23.01 Bq/L, some of which is higher than the WHO and EPA standard values (Hassan et al., 2021; Al-Jubouri & Al-Ani, 2015). Bottled and tap water in the south of Iraq also exhibited variable radon levels, where some samples showed long-term health hazard (Al-Hassani & Al-Kazemi, 2018).

4. RADIATION DOSE AND HEALTH RISKS

The Baghdad houses produced maximum annual effective dose of 0.59 mSv/year (Al-Kinani et al., 2020) and the heritage building study recorded doses in excess of 2,500 mSv/year (Al-Mousawi & Al-Janabi, 2018). Organ-specific dosimetry showed that the skin received the highest dose, then followed by the lungs and stomach (Al-Timimi & Al-Kazwini, 2019). Exposure to radon over long time periods is associated with elevated risks of lung and stomach cancer, particularly in poorly ventilated dwellings located on soils emitting high concentrations of radon (WHO, 2009; UNSCEAR, 2000).

5. GEOLOGICAL AND ENVIRONMENTAL FACTORS

Soil makeup, building materials and ventilation influence radon levels. Radon releases are increased in central and southern Iraq due to uranium rich soils (Al-Rubaiee & Al-Dabbagh, 2017). The indoor radon dilemma is due to the demand of natural stone and concrete (Al-Taie & Al-Saadi, 2017) and most often than not air permeability that would help in easy removal of internal radon Jur Jyw I Jak Tadeusz Kącik et al.28 accumulations does not succeed especially in older constructed homes (Al-Mahdawi & Al-Kubaisi, 2016).

6. MONITORING AND MITIGATION

For the determination of radon, detection instruments like CR-39 nuclear track detectors and RAD-7systemsarecommonly employed (Durridge Company, 2018). There are a number of strategies for mitigating exposure to chromium, such as increasing ventilation in manufacturing facilities with high levels of airborne chromium, treating drinking water to remove chromium and educating the public (EPA, 2012). Nevertheless, Iraq has no national radon plan of action, and the environmental legislation is still in its infancy (Ministry of Environment Iraq; 2015).

7. CONCLUSION

Radon exposure in Iraq is a complex matter related to geological, and infrastructure-related with government adoption (Regulation). While some parts of the country have safe levels of radon, there are other areas — especially in regions with uranium-rich soils and poor ventilation — where measures need to be taken as soon as possible. A national plan that includes surveillance, mass education, and policy implementation is necessary to reduce health hazards and protect the environment.

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