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Radon in Water: A Comprehensive Review of Exposure Risks, Research Gaps, and Policy Implications in Nigeria

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ABSTRACT

Radon in water represents a significant yet understudied public health risk, particularly in Nigeria, where groundwater reliance is high and regulatory frameworks are lacking. This review synthesizes current research on radon concentrations in Nigerian water sources, highlighting exposure risks, health implications, and policy gaps. Radon-222 (^{222}Rn), a carcinogenic gas from uranium decay, poses both inhalation and ingestion risks, with inhalation linked to lung cancer and ingestion causing stomach cancer. Despite global guidelines from the WHO and EPA, Nigeria lacks comprehensive regulations, and research remains little, with studies concentrated in only a few states (e.g., Ekiti, Ogun, Kwara). Findings reveal variable radon levels, often within safe limits, though some areas exceed recommended doses. The review identifies critical gaps, including the absence of baseline data in high-risk geological areas like Delta State, limited epidemiological studies on ingestion risks, and insufficient public awareness. This review calls for urgent action: expanded research, radon monitoring, and policy development to mitigate risks. By addressing these gaps, Nigeria can effectively protect vulnerable populations, particularly in rural communities dependent on groundwater. This review underscores the need for interdisciplinary collaboration to bridge science, policy, and public health in addressing radon-related hazards.

Keywords: Radon, groundwater, public health, carcinogenic risk, Nigeria.

INTRODUCTION

The Nigerian Perspective of Radon, a naturally occurring radioactive gas, is a well-established environmental health hazard, classified as a Group 1 carcinogen by the World Health Organization (WHO) WHO (2009) and the International Agency for Research on Cancer (IARC). As the second leading cause of lung cancer after tobacco smoking, radon exposure has garnered significant global attention, particularly in indoor environments where it can accumulate to hazardous levels in poorly ventilated spaces Mokobia et al. (2020). The provided context underscores the international response to this issue, with frameworks like the European Commission's 2013/59/Euratom Directive setting a reference level of 300 Bq/m³ Schmidt and Regner, 2014; McLaughlin et al. (2022) for indoor radon concentrations, and countries such as the United States, Canada, Japan, and South Korea implementing testing and mitigation programs to address this risk Kim and Yoo (2020). However, while much of the focus has been on radon in indoor air, radon in water represents a critical yet often understudied exposure pathway, particularly in Nigeria which relies greatly on groundwater sources. This introduction provides a comprehensive overview of radon in water, exploring its sources, health risks, measurement and mitigation strategies, regulatory frameworks, and research gaps, with a particular emphasis on Nigeria where research and awareness remain limited.

Background And Significance Of Radon Exposure

Radon [specifically radon-222 (^{222}Rn)] is a colourless, odourless, and tasteless radioactive gas produced from the decay of uranium-238 (^{238}U) in soil, rock, and water UNSCEAR, 2000; Mokobia et al. (2020). As a noble gas, radon is chemically inert, allowing it to move freely through porous materials and accumulate in enclosed spaces such as homes, schools, and workplaces Mokobia et al. (2020); Davis et al. (2020); Shergill et al. (2021); Vasiliev (2023). Its radioactive decay produces alpha particles, which, when inhaled, can damage lung tissue and increase the risk of lung cancer, particularly with prolonged exposure Pankaj et al. (2017). The WHO estimates that radon accounts for 3–14% of lung cancer cases globally, with the risk exacerbated by factors such as smoking and poor ventilation WHO - Radon and Health, WHO (2009). The provided context highlights that regions like Europe, North America, Japan, and South Korea have implemented robust measures to address indoor radon, driven by scientific evidence linking prolonged exposure to elevated radon levels (above 148–300 Bq/m³) with increased lung cancer risk Kim and Yoo (2020); Perko and Hevey (2024). While indoor air remains the primary exposure pathway, radon in water is an emerging concern, particularly in areas dependent on groundwater. Radon can dissolve into water from uranium-rich geological formations, such as granite or shale, and when this water is used for domestic purposes such as drinking, cooking, bathing, or washing, it can release radon gas into the indoor air, contributing to the overall inhalation and ingestion risk Al-Alawy and Hasan (2018); Omirou et al. (2022). Additionally, ingestion of radon-contaminated water introduces a potential, though less well-established, risk of internal exposure, primarily to the stomach. The U.S. Environmental Protection Agency (EPA) estimates that radon in drinking water contributes to approximately 168 cancer deaths annually in the United States, with 89% attributed to lung cancer from inhaled radon and 11% to stomach cancer from ingestion Ahmed et al. (2025). This dual exposure pathway underscores the need for a holistic approach to radon risk assessment and mitigation, integrating both air and water sources.

Sources and Pathways of Radon in Water

Radon enters water supplies primarily through the decay of uranium and radium in the Earth's crust, which releases radon gas into groundwater Cosma et al. (2008); Ali et al. (2010). Unlike surface water sources (e.g., rivers and lakes), which have lower radon concentrations due to aeration and dilution, groundwater sources such as wells, boreholes, and springs are more susceptible to elevated radon levels, particularly in regions with uranium-rich geology. For instance, areas with granitic formation, such as parts of the northeastern Delta State, although there have not been any report of high radon concentrations in groundwater in this region.

In Nigeria, where many communities rely on groundwater for domestic use, the potential for radon in water to contribute to ingestion exposure is significant but underexplored, largely due to limited research and awareness.

Health Risks Associated with Radon in Water

The primary health risk from radon in water is through inhalation of the gas released into indoor air. However, there are growing concerns regarding the health risks posed by radon exposure in groundwater Ahmed et al. (2025). The EPA's estimate of 168 annual cancer deaths from radon in drinking water in the U.S. highlights that approximately 150 deaths are due to lung cancer caused by inhaling radon gas released during water use and 18 deaths annually attributed to ingestion of radon in water. This aligns with the broader understanding of radon as a major contributor to lung cancer, with risks increasing with exposure duration and concentration Mokobia et al. (2020). The synergistic effect of radon exposure and smoking further amplifies this risk, as radon decay products can adhere to smoke particles, enhancing their deposition in the lungs Tan et al. (2019); Mokobia et al. (2020); Rani et al. (2021); Sahoo et al. (2024). The risk of ingestion, primarily associated with stomach cancer, is less certain. The EPA attributed 18 annual deaths to stomach cancer from drinking radoncontaminated water have not been consistently confirmed by epidemiological studies. The WHO notes that the biological half-life of ingested radon is short, with over 90% eliminated through exhalation within 100 minutes, suggesting limited internal exposure compared to inhalation WHO (2009). However, the potential for low-dose, chronic exposure to affect the gastrointestinal tract warrants further investigation, particularly in populations with high groundwater consumption Strauss et al. (2001); Sinha and Prasad (2020). Children may be at higher risk due to their faster respiratory rates and smaller body mass, which could result in greater relative exposure to radon released from water Branco et al. (2016). However, specific studies on pediatric populations and radon in water are scarce, representing a critical research gap. Overall, while inhalation remains the dominant concern, the combined risks of inhalation and ingestion highlight the need for comprehensive monitoring and mitigation strategies for radon in water.

Regulatory Frameworks and Guidelines

Global regulations for radon in water are less developed than those for indoor air. In the United States, the EPA recommends action if radon levels in water exceed 4,000 pCi/L (approximately 148 Bq/L), recognizing its contribution to indoor air concentrations USEPA (1999); WHO (2009). In contrast, the European Union's 2013/59/Euratom Directive focuses primarily on indoor air, with a reference level of 300 Bq/m³, and does not explicitly address radon in water. The WHO provides general guidance, suggesting that screening levels for radon in water be based on national reference levels for indoor air, with mitigation techniques like aeration or granular activated carbon (GAC) filters recommended for high concentrations WHO (2009). In Canada, while indoor air guidelines are set at 200 Bq/m³ Zhang et al. (2018), there are no specific federal standards for radon in water, though testing is encouraged, particularly for private well users. Japan and South Korea have established guidelines for indoor radon, but water-specific regulations remain limited Kim and Yoo (2020). In Africa, there is a significant regulatory gap, with countries like Nigeria, Angola, South Africa, Egypt, Tunisia and Sudan conducting limited studies but lacking comprehensive frameworks for radon in water. This absence of regulation in Africa and Nigeria in particular is compounded by resource constraints, limited expertise, and prioritization of other public health issues, such as infectious diseases.

Despite the growing concern regarding the risks associated with radon exposure in some parts of the world, there are still regions and countries where little or no attention has been given to the study and monitoring of radon. One of such country and region is Nigeria and Africa, where only a small number of researchers have channeled their effort toward the monitoring and assessment in order to address indoor radon exposure or water ingestion risk.

Research And States Disparities

In Nigeria, the situation is more critical. Only a certain location in a few states [Ogun, Jidele et al. (2021); Farai et al. (2022); Ondo, Olufemi et al. (2024); Niger, Bashir and Abdullahi (2024); Borno, Jauro et al. (2024); Abuja, Balogun and Medina (2024); Nasarawa, Madaki et al. (2024); Jigawa, Shuaibu et al. (2024); Kano, Abubakar et al. (2024); Benue, Ichoja et al. (2023); Kwara, Jimoh and Ademola (2023); Lagos, Adeola et al. (2025)], in the country have research on radon in water been conducted with focus on specific sources like, tap water, well water, underground water and schools. Researches on radon in water particularly in Delta State are virtually non-existent, despite the state's heavy reliance on groundwater. This gap is attributed to several factors which borders around limited awareness among policymakers and the public, a shortage of trained personnel in radiation protection, inadequate facilities for radon measurement, and competing priorities such as poverty reduction and infectious disease control. The lack of research infrastructure and funding further exacerbates this issue, leaving Delta state and Nigerian populations potentially vulnerable to unassessed radon risks in water.

Radon in Water in the Nigerian Context

Delta state's unique environmental and socio-economic background justifies the need for an in-depth research on radon in water. Many states in Nigeria rely on groundwater for drinking and domestic use, particularly in rural areas where wells and boreholes are primary water sources. Geological formations rich in uranium, such as those found in parts of Nigeria [e.g., Osun's pegmatites region Jimoh and Olatunji (2020); Calabar's pegmatites Ekwueme (2003); Opara et al. (2014); Jos-Plateau pegmatites Matheis and Caen-Vachette (1983)] may contribute to elevated radon levels in groundwater in these areas, yet studies are sparse. It is evident from literature of so many researches on radon in factories, dwellings and generally indoor environment, suggesting some awareness of radon risks. However, there is no published data of radon measurement in Delta state even though efforts to measure radon in water is picking up gradually in the Northern and Southwestern part of Nigeria. Radon studies in indoor environment and soil provide a foundation but do not address water sources comprehensively.

The health implications of radon in water in Delta state are particularly concerning given the state's limited healthcare infrastructure. Lung cancer, while less prevalent than infectious diseases, is a growing concern, and unassesed radon exposure could exacerbate this burden Riudavets et al. (2022). The potential ingestion risks, though less certain, are also relevant in communities with high water consumption and limited access to treated water Manawi et al. (2024); Nyemeg et al. (2025).

Knowledge Gaps and Research Opportunities

The limited research on radon in water in Nigeria, and particularly in Delta state, presents several knowledge gaps and opportunities for future study. There is a lack of baseline data on radon levels in groundwater across Delta state. Comprehensive surveys are needed to map radon concentrations and identify high-risk areas. Health Impact Studies, Epidemiological studies specific to radon in water are scarce, especially regarding ingestion risks. Research is needed to understand the association between radon ingestion and stomach cancer, particularly in areas with high human population and with high groundwater reliance. The lack of awareness among policymakers and communities hinders action. However, educational campaigns and training programs for radiation protection experts could bridge this gap.

This review aims to analyze research studies conducted in Nigeria, focusing on the main subjects addressed in these studies. A comprehensive search was carried on the Scopus database, a well regarded source for scientific literature, to assess the current understanding of radon in water exposure across different Nigerian states. Beyond identifying the key areas in existing literature, this review also seeks to highlight potential gaps and areas for investigation in future research. By examining the available studies, this review aims to provide an overview of exposure to radon in water within Nigeria, thus revealing the contributing factors and possible health risks affected communities. Ultimately, the findings from this review could inform more effective strategies, policies, and interventions to mitigate the risks associated with exposure to radon in water in Nigeria.

MATERIALS AND METHODS

To conduct this review, we performed a systematic literature search in the SCOPUS and PubMed database using the following query: “radon in water” AND “state (each state in Nigeria)” AND “nigeria”. This search was restricted to articles published between 2010 and 2025 (as it was noticed that no research work in Nigeria on radon in water was conducted and published before 2010), focusing on radon concentrations in water sources across Nigerian states. The query results are presented in Table 1 and Figure 1. The inclusion criteria for the articles were that they must be and discuss only radon in water within Nigerian states.

After the initial search, articles were screened based on their title and abstract to determine their relevance. Then, full-text articles were obtained for the relevant studies, and further screening was conducted to ensure they met the inclusion criteria. The final set of articles was analyzed to identify the main research gaps regarding radon in water exposure in Nigerian states.

Table 1: Results obtained with query from Scopus and PubMed database

States	No. of Scopus documents	No. of PubMed documents	REFERENCES
Abia			
Adamawa			
AkwaIbom			
Anambra			
Bauchi	1	0	Shu’aibu et al. (2021)
Bayelsa			
Benue	1	0	Ichoja et al. (2024)
Borno			
Cross River			
Delta			

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Ebonyi			
Edo			
Ekiti	4	0	Badmus et al. (2024); Isinkaye and Ajiboye (2017); Ajiboye et al. (2018)
Enugu			
Abuja			
Gombe			
Imo			
Jigawa			
Kaduna			
Kano			
Katsina			
Kebbi			
Kogi			
Kwara	4	1	Lawal et al. (2024); Jimoh and Ademola (2023); Michael et al. (2022); Orosun et al. (2021).
Lagos	1	2	Adeola et al. (2025); Ademola and Oyeleke (2017).
Nasarawa			
Niger			
Ogun	4	1	Ajiboye et al. (2022); Jidele et al. (2021); Fatoki and Ademola (2020); Farai et al. (2023); Rabiu et al. (2017)
Ondo			
Osun	1	0	Akindipe et al. (2025)
Oyo	1	1	Adagunodo et al. (2023); Ademola and Oyeleke
			(2017)
Plateau			
Rivers			

Sokoto			
Taraba			
Yobe			
Zamfara	1	0	Sulaiman et al. (2025)

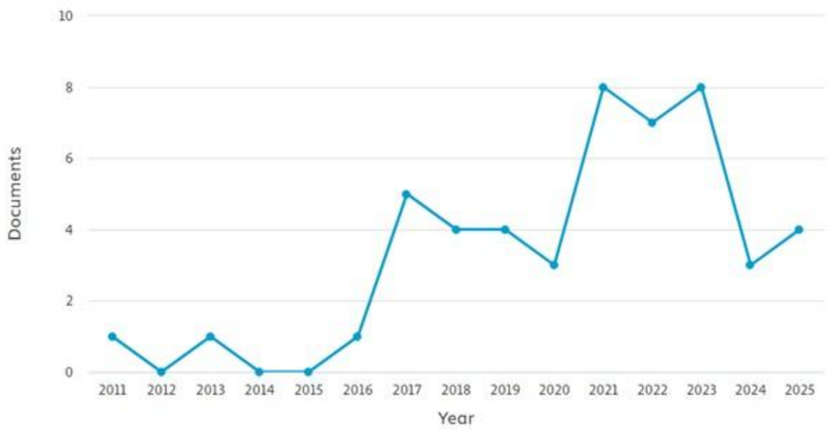

Fig. 1. Number of documents on radon in water in Nigeria per year Scopus (2025).

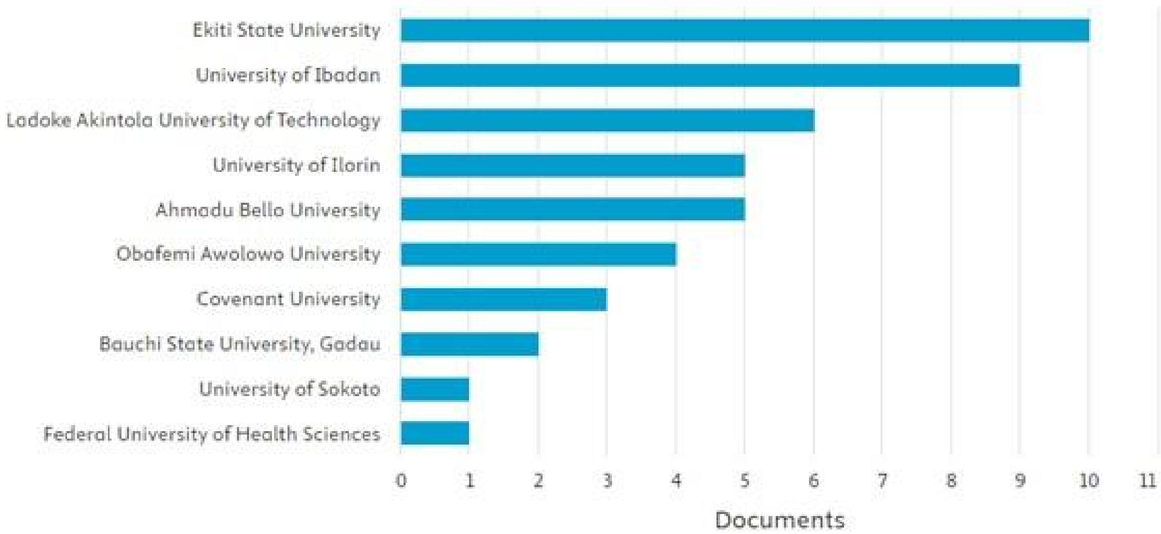

Fig. 2.Number of documents on radon in water per tertiary institution in Nigeria Scopus (2025).

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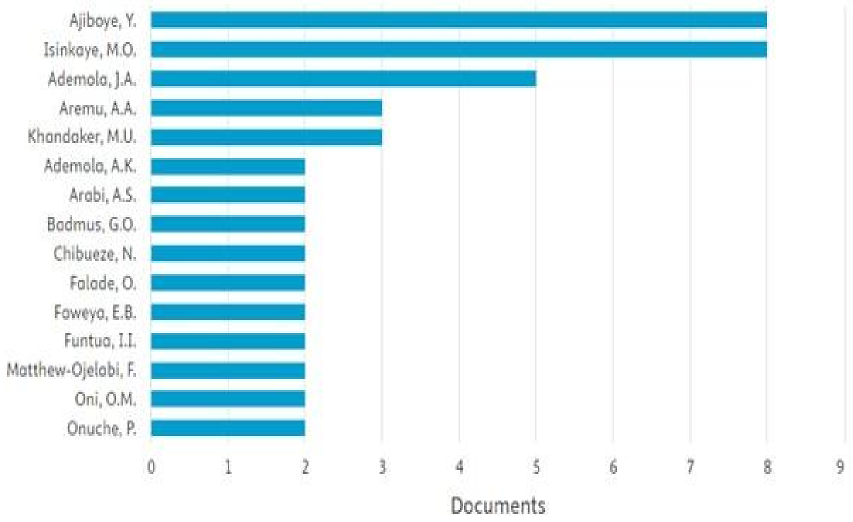

Fig. 3. Number of documents on radon in water per individual researcher in Nigeria Scopus (2025).

Geology of Nigeria

Nigeria's geology varies particularly because it comprises the Precambrian basement complexes, sedimentary basins, and younger volcanic rocks Obaje (2009); Oli et al. (2019). The country is divided into three major geological domains: the Basement Complex, the Younger Granites, and the Sedimentary Basins Rahaman (1989).

The Basement Complex, covering about 50% of Nigeria, consists of Precambrian metamorphic and igneous rocks, including migmatites, gneisses, and schists Oyawoye (1972). These rocks host significant mineral resources such as gold, tin, and tantalite.

The Younger Granites are Jurassic-aged ring complexes found predominantly on the Jos Plateau, characterized by intrusive granites, rhyolites, and associated mineralization Jacobson et al. (1958). These formations are economically important for tin and columbite mining.

The Sedimentary Basins, including the Benue Trough, Niger Delta, and Chad Basin, contain Cretaceous to Recent sediments Nwajide (2013). The Niger Delta, Nigeria's primary hydrocarbon province, is rich in oil and gas reserves, formed from thick accumulations of Tertiary deltaic deposits Doust and Omatsola (1990). The Benue Trough hosts coal, limestone, and lead-zinc deposits. Nigeria's geological diversity supports its mining and petroleum industries, making it one of the leading countries in Africa's resource sector Obaje (2009).

LITERATURE REVIEW BY STATES WITHIN NIGERIA

Bauchi State

The article, "determination of radon concentration in groundwater of gadau, bauchi state, nigeria and estimation of effective dose" shuaibu et al. (2021), investigated both radon concentration in drinking water sourced from deep-bore wells levels in gadau, bauchi state, with a particular focus on the effective dose for ingestion and inhalation of radon in water shu'aibu et al. (2021). their findings were published in radiation physics and chemistry. this study is an essential reference to understand radon exposure patterns and radiological implications of radon gas associated with the intake of groundwater in the region. the groundwater samples from gadau, bauchi state were analyzed using rad7 alpha spectrometry. their findings confirm that radon is present in the water samples and found to be higher than those reported in most literature elsewhere around the world. however, the mean annual effective dose for ingestion and inhalation were lower than permissible recommended by world health organization (who) and the international commission on radiation protection (icrp).

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Benue State

In Benue State, researchers Ichoja et al. (2024) used a Tri-Carb 1000 Liquid Scintillation Counter (LSC) to measure the radon concentrations in water samples from Ado and Otukpo LGA. The study found that the average ^{222}Rn activity for Ado and Otukpo LGAs ranged from 2.281±1.861 to 27.525±1.861 Bq/L with a mean value of 10.031±1.861 Bq/L and 2.115±0.689 to 11.367±0.689 Bq/L with an arithmetic mean of 7.574±0.689 Bq/L respectively. Although these radon values recorded are within the reference level of 100 Bql^{-1} proposed by the WHO and EU Commission. Additionally, the authors reported values of dose variations of Annual effective dose (AED) to individuals were found to increase with age and water consumption rates. The authors concluded that there is a possible occurrence of cancerous bronchial epithelium than stomach cancer over time in the study areas due to the consumption of water.

Ekiti State

In Ekiti State, a comparative measurement of radon in 100 samples of groundwater using a RAD7 radon detector was conducted by Ajiboye et al. (2018). They also estimated the radiation hazards caused from ingestion of radon in water. The concentrations of radon in groundwater reported in this study ranged between 0.9 and 472 Bq/L with a mean of 34.7 ± 4.4 Bq/L. The total annual effective dose due to inhalation and ingestion of radon in groundwater amounted is 94.7 µSv/y, which is slightly below WHO reference level of 100 µSv/y. Their findings further revealed that some locations have AED values above recommended limit an indication that groundwater samples from these areas pose significant radiological hazards to the population.

An earlier study, conducted by Isinkaye and Ajiboye (2018), created the pathway into understanding of exposure to radon in water in Ekiti state. Measurements of radon levels in deep and shallow wells in the state in order to assess the annual effective dose due to human were reported in RadioProtection, they highlighted the need for monitoring radon concentrations in water to safeguard public health. A similar study was conducted by Badmus et al. (2024). Their investigation, which was published in the Journal of Water and Health, evaluated the radiation doses to the stomach and respiratory tract due to radon in the water samples analyzed. Their results show that they are lower than WHO limit of 0.1 mSv/y for individual dose criterion. From their findings, the authors suggested the necessity for groundwater resource management and mitigation measures to safeguard the human population from radiological risks linked to radon in water.

Oyo State

In order to ascertain the safe consumption and use of water in Ibadan, the study “Radon-222 in groundwater and effective dose due to ingestion and inhalation in the city of Ibadan, Nigeria” was carried out. They reported variation in radon concentration with the geological formation of the area with arithmetic means for annual effective dose due to ingestion of radon in water were higher than WHO recommended reference dose level. His pioneering work assessed the radon levels in groundwater in 11 local government areas in Oyo state, thus laying the foundation for future studies in the region. Their findings contributed to the understanding of radon distribution in Oyo State and highlighted the need for more comprehensive radon monitoring Ademola and Abdulkareem (2019). Their findings were published in the Journal of Radiological Protection.

Further research by Adagunodo et al. (2023) focused on the “Assessment and health effects of radon and its relation with some parameters in groundwater sources from shallow aquifers in granitic terrains, southeastern axis of Ibadan, Nigeria” was conceived. Concentrations and health effects of radon in 40 groundwater samples were analyzed using RAD7 detector. Their research and findings established that no significant variation exists between radon concentrations sources in the shallow aquifers from the two settlements of Amuloko and Olorunsogo areas in Ibadan suggesting that the elevated concentration of radon in water at the settlements is due to the geological contributions of faults.

Osun State

Early this yearly, Akindipe et al. (2025), published in the journal of “Groundwater” investigated the radiological health hazard arising from ingestion of radon-laden water. This was achieved by measuring the concentrations of radon in various water sources (surface water and hand-dug well water) at Redeemer’s University campus, Ede, and its environment. Thirty five (35) water samples were collected and analyzed for radon content. They also estimated the associated radiological health hazard by calculating health risk using the annual effective dose (AED) and the excess lifetime cancer risk (ELCR). Although, they reported low AED and ELCR values lower than WHO limits, their study will serve as baseline and a path for further studies.

Ogun State

The research by Rabiu et al. (2017), published in the Jordan Journal of Physics also investigated radon levels well water samples from Abeokuta, Ogun State, Nigeria, and assessed the associated human radiation exposure. They also estimated annual effective doses from these water samples. Similar study was later conducted by Fatoki and Ademola (2020), they investigated the radon occurrence in drinking groundwater within Ogun State, and also estimated dose to human from intake of radon contributing to the public knowledge on exposure to radon through water. In 2021, Jidele et al. (2021) investigated the concentrations of radon and some heavy metals in drinking water in Ota, a fast growing city using RAD-7 thus further expanding the knowledge of radon distribution in the state. Their result was published in international journal of environmental quality. Heliyon in 2022 published an article on Pilot groundwater radon mapping and the assessment of health risk from heavy metals in drinking water of southwest, Nigeria Ajiboye et al. (2022). Their findings contributed to the understanding of radon distribution in the area and also highlighted the need for further radon monitoring of other sources of water. A year later, Farai et al. (2023) conducted a study of radiological indices estimation by measuring radon concentration in 25 samples of hand-dug well and 33 samples of borehole water in Abeokuta, south western Nigeria. This research has provided valuable data on the variation of radon concentrations in the sampled water sources. Their finds have since been published in the journal of "Applied Radiation and Isotopes."

Kwara State

Only four researches on radon in water have been conducted between 2021 and 2024 in Kwara State. Orosun et al. (2021) published an article on "The Assessment of ^{222}Rn concentration levels in ground and surface water samples and the annual effective dose associated from gold and lead mining area of Moro, Kwara State, Nigeria." Their results show high risk of exposure to radiation at the mining area and the local populace is not safe. Michael et al. (2022) assessed the annual effective dose due to intake of Radon in drinking water from abandoned tin and cassiterite mining site in Oyun, while Jimoh and Ademola (2023) used the AlphaGUARD portable radon monitor to measure Rn-222 concentrations in 101 groundwater samples from selected LGAs within the state Jimoh and Ademola (2023). Lawal et al. (2024) published their findings in the Jordan Journal of Physics where they investigated radon concentration in groundwater and potential radiation risks associated with radon0laden water. The study was conducted within Jimba-Oja, Kwara state. They reported radon concentration in the range of 3.08 Bq/L to 9.18 Bq/L with an average value of 5.00 Bq/L. The average AED for three different age groups was found to be 36.50, 54.75, and 63.88, respectively. Additional reports show that AED values for children and adults remain within recommended limit but higher for infants.

Lagos State

Only two Studies of radon in water is available on the Scopus and PubMed database. First of such research was published in 2019 in journal of Radiation protection dosimetry where Ademola and Abdulkareem (2019), assessed radon concentration in groundwater within Lagos State and also estimated the annual effective dose to humans due to intake of this water. They reported radon levels below recommended limits. Additionally, they reported effective doses from ingestion for adults, children and infants to be less than the 0.1 $mSvy^{-1}$. This study birth the foundation of radon in water studies in Lagos State. A further study was conducted by Adeola et a., (2025) to investigate radon concentration in drinking water samples collected at two tertiary Institutions within Ikorodu, Lagos State. A RAD-7 detector was used for the analysis. They reported radon levels ranging between 4.5 ± 1.1 Bq/m^3 and 25.5 ± 2.1 Bq/m^3, stating that 70% of samples analyzed were above EPA's limit. They further reported that the annual effective doses from ingestion and inhalation are under the world average values. Their findings stressed on the need and importance of monitoring radon in drinking water in the region.

Zamfara State

In Dareta, Zamfara State, a study to evaluate ^{222}Rn concentration and radiological risk in the surface water and groundwater was carried out by Sulaiman et al. (2025).Their study reported mean ^{222}Rn concentration in the range of 2.64 ± 0.10–12.30 ± 3.20 Bq/L, and the mean of the total annual effective dose in the range of 12.54–82.02 μSv/y. From their findings, they concluded that the ^{222}Rn concentrations were safe, except for two samples with values above permissible limit. They recommended that water sources in Dareta be regularly treated before consumption by the local populace. Additionally, the authors suggested that further studies were needed to better understand the distribution and sources of radon in water in the region.

CONCLUSION

Radon in water is a critical yet understudied contributor to the global radon exposure burden, with significant implications for public health. While inhalation remains the primary risk, leading to lung cancer, the potential for ingestion-related risks, particularly in groundwater-reliant regions, warrants further investigation. In Nigeria, where research on radon in both air and water is limited, the reliance on groundwater amplifies the need for targeted studies and interventions. By synthesizing current knowledge, identifying gaps, and proposing research and policy priorities, this review underscores the urgency of addressing radon in water to protect vulnerable populations, particularly in rural communities in Nigeria. Future efforts should focus on building research capacity, developing cost-effective mitigation strategies, and raising awareness to mitigate the hidden risks of radon in water.

Author Contributions

Augustine Nwabuoku: Conceived and designed the study Anita Akpolile: Collected articles for review Kparobo Agbajor: Contributed in reviewing various articles Chukwuka Mokobia: Contributed in reviewing various articles

Data Availability Statement

Data would be available upon reasonable request

Conflict of Interest

The authors have no conflict of interest

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