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PUBLIC BODY DOSE EXPOSURE FROM OUTDOOR AMBIENT RADIATION IN SELECTED AREAS OF WUSHISHI LGA NIGERIA USING GQ GMC-500+ NUCLEAR RADIATION DETECTOR

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Abstract: **This study assesses the direct body dose exposure of dwellers to outdoor background radiation in selected areas of Wushishi Local Government Area (LGA), Niger State, Nigeria. Measurements were conducted GQ GMC-500+ Nuclear Radiation Detector Monitor Dosimeter and a GPS obtained from Physical Sciences Department, Niger State Polytechnic Zungeru. The study recorded radiation dose rates in eighty (80) locations within Wushishi LGA. The highest radiation levels were observed at Dangote Company (0.20–0.21 µSv/hr), Gudugi (0.20 µSv/hr), Water Board (0.20 µSv/hr), and Tudun Wada (0.20 µSv/hr). The lowest recorded levels were at Sabon Gari (0.16 µSv/hr), River Basin (0.16 µSv/hr), and Takashanya (0.15 µSv/hr). Detail of the result is presented in Table 7.1. The mean value was 0.18 µSv/hr. The results indicate variations in background radiation levels, with some locations exhibiting higher readings than others. However, all recorded values remain within the safe limit recommended by the International Commission on Radiation Protection (ICRP). The study underscores the need for continuous monitoring of environmental radiation and further assessment of Naturally Occurring Radioactive Materials (NORMs) in both indoor and outdoor environments.**

Keywords: **Background radiation, outdoor exposure, Geiger counter, radiation dose, Wushishi LGA.**

1. INTRODUCTION

Background radiation is the level of ionizing radiation present in an environment that is not attributed to deliberate introduction of radioactive sources. It. It originates from both natural and man-made sources. Natural sources include cosmic radiation, solar radiation, external terrestrial sources, and radiation in the human body, while man-made sources primarily stem from medical imaging and industrial applications (United Nations, 2000). Natural background radiation primarily comes from cosmic radiation, terrestrial sources, internal human body radiation, and radon exposure. Globally, the average human exposure to ionizing radiation is approximately 3 mSv per year, with 80% originating from natural sources and 20% from artificial sources. Background radiation levels vary across locations, ranging from as low as 1.5 mSv annually to over 100 mSv annually in high-exposure areas such as Ramsar, Iran (United Nations, 2000). Given the potential health implications of prolonged radiation exposure, assessing radiation levels in local environments is crucial.

2. AIM AND OBJECTIVES

This study aims to assess the outdoor background radiation dose to dwellers in selected areas of Wushishi LGA, Niger State, Nigeria. The specific objectives are:

1. To determine the sampling locations using a GPS monitor.
2. To measure the outdoor radiation dose to residents using a Geiger counter.
3. To compare the measured radiation levels with global safety standards.

3. JUSTIFICATION

Understanding human exposure to ionizing radiation is crucial due to potential health risks. Exposure to excessive radiation doses has been linked to various health complications, including cancer. Literature indicates that background radiation levels vary significantly across locations, necessitating radiological surveys to ascertain exposure levels and potential risks. Conducting radiological surveys is essential to establishing baseline data that can inform safety regulations and future research.

Scope and Limitations

This study reports on a radiological survey conducted using a GQ GMC-500 Nuclear Radiation Detector to measure body dose exposure from outdoor background radiation. The study does not consider the biological effects of the recorded radiation levels.

4. LITERATURE REVIEW

Several studies have assessed environmental radiation levels in various regions. Surveys conducted in India and Pakistan indicate that average indoor radon concentrations remain below regulatory limits (Kumar et al., 2012; Khan, 2001). Similar studies in southwestern Punjab, India, revealed radon levels ranging between 21–79 Bq/m³, which is within the global average of 40 Bq/m³ (Nakamura et al., 2007). This study builds on existing research by focusing on outdoor background radiation levels in Wushishi LGA. A study in Pakistani elementary schools found that radon concentrations averaged 56 Bq/m³, below federal guideline levels (Faheem et al., 2008).

Research on background radiation levels has also been conducted in various regions, including Nigeria (Isinkaye & Emelue, 2015; Ugbede & Benson, 2018), Iran (Mortazavi & Karamb, 2005; Sohrabi & Babapouran, 2005), and Syria (Othman & Mahrouka, 2004), providing essential data on radiological hazards.

Furthermore, studies examining the health implications of natural radiation exposure have been performed in various industrial and urban settings, underscoring the importance of continuous monitoring and risk assessment (Ademola & Olatunji, 2013; Agbalagba et al., 2016; Darwish et al., 2015). Geographic Information System (GIS) mapping techniques have also been utilized to evaluate the impact of industrial activities on background radiation levels in different regions (Agbalagba et al., 2016).

Overall, the reviewed literature indicates that while background radiation levels in most areas remain within acceptable limits, some regions show elevated levels, requiring further investigation and policy interventions to mitigate potential health risks.

5. STUDY AREA

Wushishi LGA is located in Niger State, Nigeria. It has experienced population growth due to factors such as its proximity to Niger State Polytechnic, Zungeru, and its favorable agricultural landscape. The area features a mix of floodplains and granite-rich basement complexes, which may influence radiation levels. Given the limited literature on radiation studies in Wushishi, this study aims to establish baseline data for future research.

6. MATERIALS AND METHODS

6.1. Equipment Used

- GPS Monitor
- Geiger-Mueller tube-based dosimeter (Digilert Nuclear Radiation Monitor, S.E International, Inc., USA)
- Stopwatch

6.2. Data Collection

Radiation measurements were conducted at randomly selected locations in Wushishi LGA using GQ GMC-500+ Nuclear Radiation Detector Monitor Dosimeter obtained from Physical Sciences Department, Niger State Polytechnic Zungeru; Figure 6.1.

Figure 6.1: GQ GMC-500+ Nuclear Radiation Detector Monitor Dosimeter

The portable device was used to record gamma radiation dose rates at 1 meter above ground level, following Environmental Measurement Laboratory (EML) protocols (EML, 1983). Six successive readings were taken at each location, and the average value was computed. GPS coordinates were recorded to track sampling sites.

Permission was obtained from residents before conducting measurements. However, in public areas such as the Central Mosque and Secretariat, data were collected without resistance.

7. RESULTS

The study recorded radiation dose rates in eighty (80) locations within Wushishi LGA. The highest radiation levels were observed at Dangote Company (0.20–0.21 µSv/hr), Gudugi (0.20 µSv/hr), Water Board (0.20 µSv/hr), and Tudun Wada (0.20 µSv/hr). The lowest recorded levels were at Sabon Gari (0.16 µSv/hr), River Basin (0.16 µSv/hr), and Takashanya (0.15 µSv/hr). Detail of the result is presented in Table 7.1. The mean value was 0.18 µSv/hr.

S/No	Location	Gps	Activity Indoor(µs/hr)	Error (M)
1	Kwata	9.74008°N 6.07156°E	0.19	±3
2	Kwata	9.74010°N 6.07195°E	0.17	±3
3	Kwata	9.75965°N 6.07127°E	0.18	±4
4	Kwata	9.74151°N 6.07075°E	0.18	±2
5	Kwata	9.73762°N 6.07228°E	0.16	±4
6	Takashanya	9.73692°N 6.07220°E	0.15	±5
7	Takashanya	9.73593°N 6.07275°E	0.18	±5
8	Takashanya	9.73522°N 6.07224°E	0.19	±5
9	Takashanya	9.73512°N 6.07231°E	0.18	±4
10	Takashanya	9.73531°N 6.07235°E	0.19	±4
11	Unguwan Gabas	9.73374°N 6.07287°E	0.18	±3
12	Unguwan Gabas	9.73437°N 6.07328°E	0.17	±2
13	Unguwan Gabas	9.73421°N 6.07321°E	0.17	±3
14	Unguwan Gabas	9.73533°N 6.07285°E	0.18	±4
15	Central Mosque	9.73338°N 6.07504°E	0.17	±3
16	Central Mosque	9.73302°N 6.07603°E	0.17	±3
17	Secretariat	9.73211°N 6.07621°E	0.18	±3
18	Secretariat	9.73230°N 6.07550°E	0.19	±4
19	River Basin	9.72133°N 6.07914°E	0.16	±2
20	River Basin	9.72068°N 6.07116°E	0.17	±2
21	River Basin	9.72167°N 6.07920°E	0.16	±3

22	River Basin	9.72171°N 6.07832°E	0.17	±3
23	River Basin	9.72521°N 6.07872°E	0.16	±2
24	Sabon Gari	9.72433°N 6.07984°E	0.16	±2
25	Sabon Gari	9.72550°N 6.07942°E	0.17	±2
26	Sabon Gari	9.72512°N 6.07931°E	0.17	±3
27	Sabon Gari	9.72612°N 6.07921°E	0.18	±3
28	Sabon Gari	9.72710°N 6.07810°E	0.17	±2
29	Sabon Gari	9.72508°N 6.07712°E	0.16	±2
30	Sabon Gari	9.72519°N 6.07689°E	0.16	±3
31	U/katsinawa	9.72622°N 6.07425°E	0.19	±3
32	U/katsinawa	9.72610°N 6.07360°E	0.17	±2
33	U/katsinawa	9.72628°N 6.07351°E	0.17	±3
34	U/katsinawa	9.72711°N 6.07362°E	0.19	±3
35	U/katsinawa	9.72621°N 6.07381°E	0.18	±3
36	Gudugi	9.72614°N 6.07242°E	0.16	±3
37	Gudugi	9.72620°N 6.07151°E	0.17	±2
38	Gudugi	9.72631°N 6.07016°E	0.20	±2
39	Gudugi	9.72601°N 6.07212°E	0.17	±3
40	Kofan Lemu	9.72710°N 6.07122°E	0.19	±3
41	Kofan Lemu	9.72630°N 6.07082°E	0.17	±3
42	Kofan Lemu	9.72626°N 6.07125°E	0.19	±2
43	Kofan Lemu	9.72708°N 6.07191°E	0.19	±2
44	U/Barwa	9.73229°N 6.07018°E	0.19	±3
45	U/Barwa	9.73182°N 6.07095°E	0.17	±2
46	Emiworo	9.72093°N 6.07634°E	0.18	±2
47	Emiworo	9.71868°N 6.07550°E	0.17	±2
48	Emiworo	9.72751°N 6.07617°E	0.17	±3
49	Emiworo	9.71761°N 6.07281°E	0.18	±2
50	Emiworo	9.72800°N 6.07371°E	0.17	±3
51	U/Madaki	9.73258°N 6.07154°E	0.17	±3
52	U/Madaki	9.73511°N 6.07261°E	0.18	±2
53	U/Madaki	9.72981°N 6.07310°E	0.18	±2
54	U/Madaki	9.73620°N 6.07151°E	0.17	±3
55	U/Madaki	9.72891°N 6.07388°E	0.17	±2
56	Water Doard	9.73991°N 6.07309°E	0.20	±5
57	Bakin Kasuwa	9.73229°N 6.07098°E	0.19	±3
58	Bakin Kasuwa	9.73182°N 6.07095°E	0.17	±2
59	Tudun Wada	9.73293°N 6.07312°E	0.20	±4
60	Tudun Wada	9.72881°N 6.07301°E	0.20	±4
61	Tudun Wada	9.72991°N 6.07321°E	0.19	±3
62	Tudun Wada	9.72890°N 6.07290°E	0.18	±4
63	Tudun Wada	9.72813°N 6.07380°E	0.19	±5
64	Tudun Wada	9.73907°N 6.07289°E	0.17	±3
65	Tudun Wada	9.73931°N 6.07371°E	0.18	±3
66	U/Galadima	9.74601°N 6.07361°E	0.19	±4

67	U/Galadima	9.74147°N 6.07261°E	0.20	±3
68	U/ Galadima	9.74171°N 6.07181°E	0.19	±3
69	Dangote Co.	9.75703°N 6.09520°E	0.20	±4
70	Dangote Co.	9.75651°N 6.09198°E	0.20	±3
71	Dangote Co.	9.75701°N 6.09017°E	0.21	±3
72	U/Sheshi	9.73771°N 6.08919°E	0.19	±4
73	U/Sheshi	9.73951°N 6.09126°E	0.18	±3
74	U/Sheshi	9.72541°N 6.07398°E	0.18	±2
75	U/Sheshi	9.72196°N 6.07292°E	0.17	±2
76	Kanwuri	9.72810°N 6.07319°E	0.19	±3
77	Kanwuri	9.72516°N 6.07212°E	0.19	±3
78	Kanwuri	9.73119°N 6.07219°E	0.18	±3
79	U/Shagali	9.73281°N 6.07133°E	0.18	±4
80	U/Shagali	9.72910°N 6.07210°E	0.18	±5

8. DISCUSSION

Comparing the results of this study with previous research by Mohammed Sani Isah (2021), the radiation dose rates observed in Wushishi are approximately twice the recorded average in his study. This variation may be attributed to geological factors as well as human activities influencing radiation levels. However, all recorded values remain below the ICRP's recommended annual exposure limit of **1 mSv** for the general public (ICRP, 1990). Hence does not pose any immediate radiological health risk to the inhabitant of the town.

9. CONCLUSION

The study confirms that radiation dose levels in Wushishi LGA are within safe exposure limits. Variations in radiation levels across locations may be attributed to local geological differences. While no immediate radiological hazards were detected, continued monitoring is essential to assess long-term exposure risks.

10. RECOMMENDATIONS

- Further research should assess the presence of NORMs in both indoor and outdoor environments.
- Additional radiological parameters should be evaluated to understand long-term exSposure risks.
- Awareness programs should be conducted to educate residents about background radiation and its potential health effects.

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