GEORGIAN BIOMEDICAL NEWS
VOLUME 2. ISSUE 3. JULY-SEPTEMBER 2024

The External Radiation Dose of the Population Tbilisi, Georgia

Tamar Saganelidze[1,ID], Nino Vephkhvadze[1], Tea Kochoradze-Marghishvili[1,ID], Nino Kiladze[1,ID]

DOI: 10.52340/GBMN.2024.01.01.78

ABSTRACT

Background: Ionizing radiation constitutes a significant environmental factor of concern. Numerous countries study natural radiation levels in unrestricted and restricted areas. Understanding natural radioactivity is crucial for assessing potential radiological risks to human health and implementing necessary local controls.

Objectives: This study aims to assess the average annual external radiation doses received by the population of Tbilisi.

Methods: The research employed a PKCB-104 portable dosimeter capable of calculating gamma radiation equivalent doses within the range of 0.1-99.99 μZv/h.

Results: The study assessed radiation levels in 60 points (360 observations) in open areas and 80 points (480 observations) in closed areas across various municipalities in Tbilisi. Data analysis was conducted using Microsoft Excel. The average annual external radiation dose for the Tbilisi population, excluding radon exposure, was found to be 0.9 mZv/year. This figure slightly exceeds the upper limits reported in European countries (0.6-0.8 mZv/year).

Conclusions: Based on the study findings and considering that one-third of the total radiation exposure originates from external sources and the remaining two-thirds from internal sources, the average annual total radiation dose (external and internal combined) for the population in the study area is likely relatively high. Therefore, implementing preventive measures to mitigate these exposures is recommended.

Keywords: Annual dose; ionizing radiation; natural radioactivity.

BACKGROUND

Ionizing radiation is a critical environmental factor on Earth's surface, depths, and atmosphere. Humans are exposed to external and internal radiation sources through water, air, and food. The natural radiation background, originating from soil, atmospheric, and cosmic sources, constitutes the primary radiation exposure for the population.

Annual radiation doses from natural sources typically range from 1.5 to 3.5 millisieverts (mSv) per year, with localized areas experiencing levels exceeding 50 mSv.[1-3]

Terrestrial radiation is primarily attributed to isotopes such as 40K, 232Th, 238U, and their decay products, varying in concentration across Earth's surface due to geological and geographical factors, as well as the radionuclide content of regional construction materials.[4,5]

Research on natural radiation levels in unrestricted and restricted areas is conducted worldwide. Understanding natural radioactivity is crucial for assessing potential radiological risks to human health and for enhancing local regulatory measures.[4-6]

METHODS

This study aimed to evaluate the average annual external radiation doses affecting the population of Tbilisi, focusing on potential health impacts and proposing preventive measures where necessary.

The research utilized a PKCB-104 portable dosimeter capable of measuring gamma radiation equivalent doses within the range of 0.1-99.99 μZv/h. The radiation background was measured at least 6 meters away from any walls in open areas. Each measurement point underwent six measurements, with results averaged arithmetically.

The data obtained from these measurements were employed to calculate the annual effective doses for both open and closed areas using the following formulas:

$$IAED\ (mSv/year) = X\_mean \times 8760\ hours/year \times 0.8 \times CFI$$

where IAED represents the annual effective radiation dose for buildings, X_mean denotes the average measurement result, 0.8 corresponds to the time spent indoors, and CF is the conversion factor (0.7 for adults);

$$OAED\ (mSv/year) = Y\_mean \times 8760\ hours/year \times 0.2 \times CF$$

where OAED signifies the annual effective radiation dose for open spaces, Y_mean denotes the average measurement result, 0.2 represents the time spent outdoors, and CF remains the conversion factor (0.7 for adults).

RESULTS

In Tbilisi, the research was conducted across ten municipalities, with measurements taken at six different points within each municipality. Each measurement point underwent six repetitions, both in open and closed areas.

Specifically, radiation background readings were obtained from 60 points (360 observations) in open areas and 80 points (480 observations) in closed areas across the municipalities of Tbilisi. Data processing was carried out using Microsoft Excel.

Raw data for indoor and outdoor areas were computed, and based on these, the average annual gamma radiation doses for open and closed areas were calculated. The overall average of these two doses was determined, and deviations of each data point from this overall average were computed. Consequently, standard deviations, labeled as st dev 1 and st dev 2, were derived: 0.1356 for outdoor and 0.3715 for indoor areas.

It was observed that the data points for indoor areas exhibited more excellent dispersion, reflected in the higher standard deviation compared to outdoor areas. This disparity is also evident in percentage terms: the data points for closed areas show a deviation (exceedance) from raw data by approximately 9%, whereas for open areas, this deviation is around 6%.

The data collected from open areas in Tbilisi shows radiation levels ranging from 0.104 to 0.145 µZv/h, which is somewhat higher than the rates observed in Western European countries (30-80 nGy/h, equivalent to 0.03-0.08 µZv/h) (Tab.1).

TABLE 1. Radiation background of open areas and buildings of Tbilisi and external radiation doses of the population

		Radiation background (mkZv/h)		Average annual effective radiation dose at the expense of external radiation (mZv/year)		
	Municipality	Open areas	Buildings	Open areas (20%)	Buildings (80%)	Total dose
1	Saburtalo	0.113	0.127	0.143	0.701	0.844
2	Vake	0.131	0.129	0.159	0.779	0.938
3	Mtatsminda	0.141	0.128	0.173	0.848	1.02
4	Krtsanisi	0.122	0.122	0.150	0.735	0.887
5	Isani	0.129	0.133	0.158	0.775	0.933
6	Samgori	0.145	0.135	0.178	0.873	1.05
7	Didube	0.119	0.131	0.146	0.716	0.862
8	Chugureti	0.104	0.113	0.128	0.627	0.755
9	Gldani	0.121	0.137	0.148	0.726	0.874
10	Nadazaladevi	0.121	0.130	0.148	0.726	0.874
			Average	0.1531	0.7506	0.9037

For buildings in Tbilisi, radiation levels range from 0.122 to 0.137 µZv/h, with an average of 0.129 µZv/h. This average is slightly higher than the rates observed in Western European countries (50-80 nGy/h, equivalent to 0.05-0.08 µZv/h). Notably, the Gldani district exhibits relatively high radiation levels at 0.137 µZv/h, likely due to elevated activity levels in building materials.

The average annual radiation dose for the population of Tbilisi attributed to building radiation is 0.75 mZv/year, exceeding similar rates observed in European countries (0.2-0.5 mZv/year).

Regarding the radiation background from open areas, the average annual dose for Tbilisi is 0.15 mZv/year. In specific locations, the highest recorded rate was in Samgori at 0.145 µZv/h, corresponding to an annual dose of 0.178 mZv/year. The lowest rate was in Chugureti at 0.104 µZv/h, resulting in an annual dose of 0.128 mZv/year. These findings align with the upper limits observed in European countries (0.05-0.1 mZv/year).

DISCUSSION

The average annual dose of external radiation for the population of Tbilisi, excluding radon exposure, is 0.9 mZv/year, slightly exceeding the upper limit observed in European countries (0.6-0.8 mZv/year).

Based on the research data, considering that one-third of the total radiation dose originates from external sources and the remaining two-thirds from internal sources, it is likely that the average annual total radiation doses (external and internal combined) for the population in the study area are relatively high. Consequently, implementing preventive measures to reduce these exposures is advisable.

Managing and reducing the radiation dose from natural sources poses significant challenges. Therefore, focusing on controlling artificial radiation sources and standardizing received doses to reduce overall population exposure is more effective. This involves accurately assessing the necessity and risks associated with specific medical radiological procedures (such as X-rays and CT scans) contributing significantly to population radiation doses. Other measures include ensuring the proper use of mineral fertilizers, identifying and regulating radionuclides in food products to prevent additional internal radiation exposure, utilizing construction materials with low specific activity, adhering to radiological standards for construction materials, mitigating the ingress of radon and thoron into buildings, promoting regular ventilation of living spaces, and conducting educational campaigns on radiation safety and hygiene among the population.

CONCLUSIONS

The average annual radiation dose attributable to building radiation for the population of Tbilisi is 0.75 mZv/year, which exceeds comparable rates observed in European countries (0.2-0.5 mZv/year).

In contrast, the average annual radiation dose from background radiation in open areas of Tbilisi is 0.15 mZv/year. During monitoring, the highest recorded rate was in Samgori, at 0.145 µZv/h, while the lowest was in Chugureti, at 0.104 µZv/h.

AUTHOR AFFILIATION

1 Department of Hygiene and Medical Ecology, Public Health Faculty, Tbilisi State Medical University, Tbilisi, Georgia.

REFERENCES

1. Estokova A, Singovszka E, Vertal M. Investigation of building materials' radioactivity in a historical building - a case study. Materials. 2022;15(19):6876. doi: 10.3390/ma15196876.
2. Bahreini Toosi MT, Haghparast M, Darvish L, Taeb S, Afkhami Ardekani M, Dehghani N, Refahi S. Assessment of environmental gamma radiation

ISSN (Online): 2720-8796 ISSN (Print): 2720-7994

(outdoor and indoor spaces) in the region of Bandar Abbas Gachine. J Biomed Phys Eng. 2020;10(2):177-186. doi: 10.31661/jbpe.v10i2.552.
3. Oladele BB, Arogunjo AM, Aladeniyi K. Indoor and outdoor gamma radiation exposure levels in selected residential buildings across Ondo state, Nigeria. Int J Radiat Res. 2018;16(3):363-370. doi: 10.18869/acadpub.ijrr.16.3.363.
4. Liu C, Benotto M, Ungar K, Chen J. Environmental monitoring and external exposure to natural radiation in Canada. J Environ Radioact. 2022 Mar;243:106811. doi: 10.1016/j.jenvrad.2022.106811.
5. Gelashvili K, Vepkhvadze N, Kiladze N. Radiation hygiene. Tbilisi; 2014:61-63.
6. Mc Laughlin JP. Some characteristics and effects of natural radiation. Radiat Prot Dosimetry. 2015 Nov;167(1-3):2-7. doi: 10.1093/rpd/ncv2.

Georgian Biomedical News
ISSN (Online): 2720-8796 ISSN (Print): 2720-7994