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RESEARCH ARTICLE

ANNUAL EFFECTIVE DOSE EQUIVALENT AND EXCESS LIFETIME CANCER RISK OF FOUNDJARA, CAMEROON

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ABSTRACT

Background: Assessing exposure levels is an important tool for public radiation protection. This study was conducted in a prospective setting to assess the annual effective dose equivalent and the Excess Lifetime Cancer Risk of Foundjara. **Material and methods**: This is a prospective dosimetric study of 54 houses, using a portable Radiation dosimeter for measurements and UNSCEAR method for analysis. **Results**: The population of Foundjara are exposed to an effective dose of 1.37±0.06 mSv/year for children under 5 years old, 1.22±0.06 mSv/year for children between 6 and 15 years old and 1.07±0.06 mSv/year for adults. The Excess Lifetime Cancer Risk is 4.16×10^{-3} for children under 5 years old, 3.70×10^{-3} for children between 6 and 15 years old, and 3.23×10^{-3} for adults. **Conclusion**: Our results suggest that the population of Foundjaraare exposed to natural doses above radiation protection guidelines.

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INTRODUCTION

Natural exposure can be either terrestrial or cosmic.Exposure to telluric radiation is mainly related to the presence of primordial radionuclides as well as different components of their respective decay chains in the soil. It is particularly high in granite regions (IRNS), 2011. The assessment of the natural radiation field in the world is mainly used to establish the basis for radiation protection in order to protect human beings. Exposure comes from two main sources: internal and external source. Internal exposure usually results from food ingestion and gas inhalation. External exposure results from ambient radioactivity [Ramachadran, 2011].To assess these exposures, studies on the level of natural radioactivity have been conducted in a number of countries around the world. The annual exposure of several countries varies from 0.3 to 0.6mSv [Senthilkumar, 2010]. While the global average value is 0.48 mSv [United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), 2000]. Exposure to natural radiation studies are rarely conducted in Cameroon. However, the rate of urbanisation is growing. This increases the factors that can change the characteristics of the environment. Foundjara is a locality plagued by urbanisation and human activities. In 2014, a study conducted in this locality determined a high geoaccumulation index for heavy metals such as cadmium and lead that have radioactive isotopes [Barkai, 2014].

The capacity of soil to retain radioactive elements depends on its physical, chemical and biological characteristics [Messele, 2023]. Studies have shown that there is a significant relationship between the concentration of some heavy metals and the ambient dose equivalent in the environment [Nugraha et al, 2022]. Estimating the distribution of radiation dose is essential for assessing the health risk of a population. It serves as a reference for documenting changes in environmental radioactivity due to anthropogenic activities [Obed, 2011]. This study is being conducted to assess the annual effective dose and the excess lifetime cancer riskof Foundjara.

MATERIALS AND METHODS

Site features: Foundjara is located in Ngaoundere, Adamawa region of Cameroon. Ngaoundere is situated in the volcanic line of [9], and contain volcanic soils. The site is located 2 km from Lake Dang between 13°28' and 13°32' East longitude, 7°23' and 7°27' Nord latitude and 1,076 Km of altitude (Figure 1).About 200 people live in Foundjara.The main activities are agriculture, with significant use of fertilisers and various pesticides [Baska, 2013], and fishing.The houses are mostly built with mud bricks. The construction plans favours a high thermal inertia.

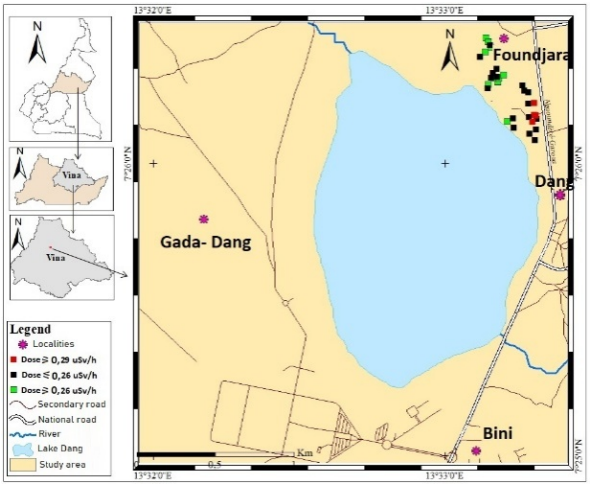

Figure 1. localisation of Foundjara

Measurement method: The absorbed dose rates in air were measured using a Portable Radiation dosimeter. The RAD-35 X, Gamma and Beta Dosimeter was mounted on a one-meter gallows above the ground indoors. The dosimeter is mounted outside on the gallows 6 meters from the walls of the houses. We recorded stabilised values within one hour while standing at a respectful distance away from the dosimeter [Mahmoud, 2014]. The GPS recording tool, was used to provide the Latitude, Longitude and Altitude of every point of measurement.

Radiation analysis: To evaluate the Annual Effective Dose Equivalent (AEDE) of every house of the site, we used the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) method [United Nations Scientific Committee on the Effects of Atomic Radiation, 2000].

$$AEDE = (D_{in} \times T \times OF \times CC \times 10^{-3}) + (D_{out} \times T \times OF \times CC \times 10^{-3}) \quad (1)$$

Where: $D_{in}$is the absorbed dose rate in the air Indoor in µSv/h;$D_{out}$is the absorbed dose rate in the air Outdoor in µSv/h; T=one year = 8760h;CC is the Conversion Coefficient which is 0.9 for children under 5years old, 0.8 for children between 6 and 15 years old and 0.7 for adults [(UNSCEAR), 2008]. OF is the Occupancy Factor which is 0.2 outdoor and 0.8 indoor. The annual effective dose rate due to cosmic radiation where evaluated by using the following method:

$$E_I(Z) = E_I(0)[0.21e^{-1.649z} + 0.79e^{0.4528}\ ] + E_N(0)b_N e^{a\,z} + 0.01 \quad (2)$$

Where:$E_I(0) = 0{,}27\ mSv/year$ is the annual effective dose from cosmic radiations at sea level; Z is the altitude of the point of measurement in kilometres (Km) [UNSCEAR), 2008];$E_N(0)$ is the effective dose rate at sea level due to neutrons; b_N= 1 and a = 1 km^{-1} for z < 2 km; b_N= 2 and a = 0.7 km^{-1} for z > 2 km; the parameter 0.01 is the radiation due to cosmogenic radionuclides in mSv/ year [UNSCEAR), 2008].

The Excess Lifetime Cancer Risk (ELCR): The International Commission on Radiological Protection(ICRP) has calculated the probability of fatal cancer. These values relying primarily the assessment of radiation effects by scientific committee such as UNSCEAR and the Biological Effects of Ionising Radiation (BEIR) [Taskin et al., 2009].

$$ELCR = E \times DL \times RF \times 10^{-3} \quad (3)$$

Where: E is the effective dose of the radiation; DL is the average Duration of Life which is 60,32 years in Cameroon according to the world health organisation [World Health Organization, 2022]; RF is the Risk Factor (Sv^{-1}) and represent the fatal cancer risk per Sievert. For stochastic effects from low dose background radiation, ICRP 103 suggests the value of 0.05 Sv^{-1} for the public exposure (ICRP), 2007].

RESULTS

The average annual effective dose equivalent of Foundjara is 1.37±0.06mSv/year for children under 5 years old, 1.22±0.06mSv/year for children between 6 and 15 years old and 1.07±0.06mSv/year for adults (Table 1). The average dose rate due to cosmic radiation in Foundjara is 0.68 mSv/year. The excess lifetime cancer risk is 4.16×10^{-3} for children under 5 years old, 3.70×10^{-3} for children between 6 to 15 years old and 3.23×10^{-3} for adults (Table 2).

Table 1: Average Annual effective dose equivalent (AEDE) of Foundjara

	a	b	c
AEDE	1,37±0,06	1,22±0,06	1,07±0,06
Max	2,08±0,03	1,85±0,03	1,61±0,03
Min	1,08±0,03	0,96±0,03	0,84±0,03

a: children between 0 and 5 years old; b: children between 6 and 15 years old; c: adults

Table 2. Average ELCR of Foundjara for all age group

$ELCR\times10^{-3}$	a	b	c	UNSCEAR
$ELCR_{IN}$	3,22	2,86	2,50	1,16
$ELCR_{OUT}$	0,94	0,84	0,73	0,29
$ELCR_T$	4,16	3,70	3,23	1,45

a: children between 0 and 5 years old; b: children between 6 and 15 years old c: adults; $ELCR_{IN}$: ELCR for indoor; $ELCR_{OUT}$: ELCR for outdoor; $ELCR_T$: total ELCR

DISCUSSION

The results obtained show that, the average annual effective dose equivalentis higher than the worldwide average dose rate obtained by the UNSCEAR committee [(UNSCEAR), 2000]] and the ICRP recommendations [(ICRP), 2020]. The average annual effective dose due to cosmic radiation is higher than the worldwide value given by the UNSCEAR committee [UNSCEAR), 2008]. These results can be explain by the geographical characteristics of Foundjara. The altitude of this region is greater than 1 km, and it has been described that exposure to cosmic radiation increases with altitudes above 1 km (IAEA), 2004]. In the other hand, a high geoaccumulation index of cadmium and lead have been founded in the Lake Dang near Foundjara locality [UNSCEAR), 2008]. It has been proven that, there is a relationship between the geoaccumaltion of heavy metals such as cadmium and lead and radioactive pollution [Nugraha et al. 2022]. They can be spread through groundwater (wells) or surface water due to their solubility [Lu, 2017].The population of Foundjara use the water and soil from Lake Dang to make their building materials, this can explain the high level of indoor radiation values. In addition, the extensive use of phosphate fertilisers and various pesticides could increase the activity of naturally occurring radionuclides in the soil of Foundjara. Phosphate fertilisers and some pesticides have been associated with the increase of natural radionuclide such as ^{40}K activity [Saher et al., 2013].The high value of the annual effective dose led to a high ELCR for all age groupsabove the worldwide average [UNSCEAR), 2008]. The ELCR of all age group of Foundjara is also higher than those obtained in Iraq [Mohammed, 2017] and India [Ramasany et al., 2009]. These results are directly related to the natural radiation field of Foundjara which is higher than the recommendations.

CONCLUSION

The annual effective dose equivalent due to natural radiation has been assessed in Foundjara. The values obtained are higher than the worldwide average for all age groups. The ELCR obtained is also higher than the recommended limits. Our results reveal that geographical characteristics and the use of phosphate fertiliser could be responsible of the increase ofthe annual exposure and the probability of developing cancers in Foundjara.These results can be

used as a reference for future environmental radiation protection measures.

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GLOSSARY OF ABBREVIATIONS

AEDE: Annual Effective Dose Equivalent
CC: Conversion Coefficient
BEIR: Biologic Effects of Ionising Radiation
DL: Duration Life
ELCR: Excess lifetime Cancer Risk
IAEA: International Atomic Energy Agency
ICRP: International Commission on Radiological Protection
OF: Occupancy Factor
RF: Risk Factor
UNSCEAR: United Nations Scientific Committee on the Effects of Atomic Radiation
IRNS: Institut for Radiation Protection and Nuclear Safety

REFERENCES

IRSN change to IRNS: Institut for Radiation Protection and Nuclear Safety Institut de radioprotection et de sûreté nucléaire (IRSN).Conséquences environnementales d'un rejet radioactif accidentel et voies d'exposition des personnes. P.1, 2011 ;

Ramachadran. T. V. Background radiation, people and the environment. Iran J. Radiat Res. 9(2). Pp.63-76, 2011;

Senthilkumar, B. V. Dhavamani. S. Ramkuna,P. Philominathan. Measurement of gamma radiation levels in soil samples from Thanjavur Using γ-Ray spectrometry and estimation of population exposure. J. Med. Phys. 35. Pp. 48-53, 2010;

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR).Sources and effects of ionizing radiation (report to the general assembly). United Nation, New York. Vol 1 annex B: exposures from natural radiation sources. Pp.83-139, 2000;

Barkai, O. Nga, L.E. Ondoa, A.D.B. Évaluation du niveau de pollution par les métaux lourds des lacs Bini et Dang, Région de l'Adamaoua, Cameroun', *Afrique Science*. 10(2), Pp.184–198, 2014;

Messele, K. K. T. D. Tilahun. Measurement of radioactivity levels and determination of Radiological Hazard Risks in areas of irrigated vegetable agriculture soils. Southwestern Lake HawassaSidama Region, Ethiopia. Applied Radiation and Isotopes. Vol 194, Pp.1-3, 2023;

Nugraha, E. D. J. Mellawati,Wahyudi, Kranrod, C. Makhsun, H. Tazoe, H. Ahmad, M.Hosoda, N. Akata, S.Tokonami. Heavy Metal Assessments of Soil Samples from a High Natural Background Radiation Area, Indonesia. Toxics. 10(1):39, Pp 2-4, 2022;

Obed, E. A. R. A. Onoja. evaluation of natural Radioactivity in Soil, Sediment and water samples of Niger Delta (Biseni) flood plain Lakes, Nigeria. Journal of Environmental Radioactivity. 102, Pp. 667-671, 2011;

Marzoli, A. E. M.Piccirillo, P. R. Renne,G. Bellieni,M. Iacumin, J. B. Nyobe,A. T. Tongwa.The cameroon volcanic line revisited: Petrogenesis of continental basaltic magmas from lithospheric and asthenospheric mantle sources', *Journal of Petrology*. 41(1), pp. 87–109, 2000;

Baska. T. D. V. Consequences socio-environnementales et sanitaires du maraîchage dans les bas-fonds de Bini-Dang (périphérie nord de la ville de ngaoundere, Cameroun). Annales de l'université de moundou, série A, faculté des lettres, arts et sciences humaines. Vol 1(1), ISSN 2304-1056, pp.10-11, 2013;

Mahmoud, A. P. A. Mahdi, N. Iraj, A. Majid. Annual effective dose from environmental gamma radiation in Bushehr city. Journal of environmental Health Sciences & Engineering. 2014. P.2-4;

UNSCEAR sources and effects of ionizing radiation United Nations Scientific Committee on the Effects of Atomic Radiation, Exposure of the public and Workers from various sources of radiation. Pp. 223-246, 2008;

Taskin, H. M. Karavus, P. Ay, A. Topuzoglu, S. Hidiroglu, G. Karahan. radionuclide concentration in soil and lifetime cancer risk due to gamma radioactivity in Kirklareli, Turkey. Journal of environmental Radioactivity. 100, pp. 49-53, 2009;

World Health Organization (WHO) data.who.int, Cameroon, [Country overview].2022;

International Commission On Radiological Protection (ICRP) recommendations. ICPR Publication 103, Elsevier, pp. 147-148, 2007;

International Commission On Radiological Protection (ICRP), for R.P. ICRP Publication 144: Dose Coefficients for External Exposures to Environmental Sources, Annals of the ICRP. Publication 144. 2020;

International Atomic Energy Agency (IAEA). Radiation, People and the Environment. IAEA/PI/A.75 / 04-00391, pp.1-85, 2004;

Lu, H. E. Campbell, D. E. Campbell, C. Wang, H. Ren, H. EPA Public Access, *Atmospheric Environment*, 23(1994), pp. 248–258, 2017;

Saher, M. S. Darwish, M. El-Bahi, T. Amany, N. F.Sroor, A. Ahoma. Natural radioactivity assessment and radiological Hazards in soils from Qarun lake and Wadi El Rayan in Faiyum Egypt. Open journal of soil science, N° 3, pp. 289-296, 2013;

Mohammed, R.S. R.S. Ahmed. Estimation of excess lifetime cancer risk and radiation hazard indices in southern Iraq. Environ Earth Sci 76, pp.1-9, 2017;

Ramasany, V. G. Suresh, V. Meenakshisundaram, V. Gajendra. Evaluation of natural radionuclide content in River sediments and excess lifetime cancer risk due to gamma radioactivity. Research journal of environùental and earth sciences, 1(1), pp. 6-10, 2009.

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