Biobacta Journal of Biochemistry and Molecular Biology
https://bjbmb.org
BJBMB
SPBH

Original article

Biological effect of radiation on human Interleukin-12 in Babylon governorate, Iraq

Oday Saleh Jumaa

Open College of Education, Wasit Study Center, Suwaira City, 52002, Iraq

Corresponding author:

Dr. **Oday Saleh Jumaa**

Open College of Education, Wasit Study Center, Iraq, Suwaira City, 52002.

E-mails:audaysalih@gmail.com

DOI: https://doi.org/10.71428/BJBMB.2026.0109

Abstract

The nuclear radiation caused by radionuclides and from the sources of activity has become a major part of life, as it is a part of our health, food, and has several applications in several fields, including biology, medicine, agricultural fields, industrial field and in a nuclear power station. This study aims to measure the natural radioactivity produced by natural radionuclides 238U, 232Th series, and 40K in the old urban neighborhoods (old buildings) in Babylon governorate (Iraq), which was chosen as a place to study; it included ten regions: AL-Krad, AL-Taies, Jabbawyin, AL-Mahdia, Jubran, AL-Taaq, AL-Jammien, AL_Wardia, AL-Galadj, and Kretaa. A total of seventy samples of soil were collected from regions under study. The 238U, 232Th series, and 40K concentrations were measured in the (20 cm) depth soil using a γ-ray spectrometer with the aid of the NaI (Tl) detector. The average values for the radiological parameters in the old buildings determined in the soil samples for Raeq, Dγ, Hex, and Hin were (65.415 Bq/kg, 31.267 nGy/h, 0.225, and 0.180), respectively. It may be inferred that these radionuclides in the soil at research locations pose no hazard to the health of the residents of these areas. The obtained results from the old buildings revealed that the correlation between IL-12 and natural radioactivity is close to the normal value in comparison with the control. The radiological parameters for the soil samples of the old urban neighborhoods (old buildings) in Babylon governorate, Iraq, were found within the internationally permissible limits for Raeq, Dγ, Hex, and Hin.

Keywords: Hex, Dγ, IL-12, study area.

Introduction

The nuclear radiation caused by radionuclides and from the sources of activity has become a major part of life, as it is a part of our health, food, and has several applications in several fields, including biology, medicine, agricultural fields, industrial field and in a nuclear power station. Henri Becquerel discovered in 1896 that penetrative rays that were later categorized as α, β, and γ rays are released as a result of the uranium radioactive decay, thereby creating a new area of research into radioactive substances and the radiations they release (1). When our planet was formed more than four and a half billion years ago, the material from which it was formed contained many radioactive elements, and since that time, the isotopes that have a short half-life have decayed, and only those with a long half-life (100 billion years or more) (2). Research on

Received: January 24, 2026. Accepted: March 25, 2026. Published: May 21, 2026

radiation exposure offers essential radiological baseline data. Such knowledge is crucial for determining how much radiation humans are exposed to from both natural and artificial sources, as well as for developing radiation protection laws and regulations (3). There are several naturally occurring radioactive materials (NORMs) in the earth, and they may be found in a variety of geological formations. Research on natural radioactivity is essential not only to understand the effect of radiation but also because it is crucial to health physics. Consequently, research on measuring natural radioactivity in the soil is crucial to determining how much the natural background activity will vary over time as a result of radiation spread (4). The main source of radiation exposure and one of the sources of nourishment for humans is soil. Knowing how radioactivity is distributed in the soil is essential. In the soils from which the soils emerge, there are various amounts of naturally occurring environmental radioactivity and the related external exposure from gamma radiation levels (5). Their daughter products and 40K, present in soil and rocks, which in turn rely on the local geology of the area in question, vary according to these dosages (6).

Several scientific fields are very interested in understanding how natural radionuclides are distributed in the environment and how concentrated they are in soil (7). The compositions of the soils and rocks that contain natural radionuclides determine how much of the background radiation is terrestrial. Natural radioactivity levels are influenced by geological factors, particularly in the rocks and soil where they are present in various amounts (8). According to the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) (1993), estimated that the average global dose from natural radiation sources in normal areas is 2.4 mSv.y-1, while the average global dose from all man-made sources, including medical exposure, is approximately 0.8 mSv.y-1 (9). To save the general health from the radiation risk caused by NORMs, the measurement of activity in the environment is important to consider its biological effect on the human, which has become the focus of major notice by the International Atomic Energy Agency (IAEA) in recent years (10). The most prevalent cause of internal radiation exposure from radioactive nuclides. External radiation exposure from radioactive nuclides often results from direct gamma radiation (11). Internal exposure is the consequence of radioactive chemicals that are naturally present in food, water, and the environment entering the body through ingestion and breathing Aim of the Study are Measure the specific activity (radioactivity) of 238U, 232Th and 40K in soil samples taken from the old urban neighborhoods in Babylon governorate (Iraq) by using a gamma ray spectrometer analysis system consists of a Sodium Iodide Detector Dotted with Thallium NaI (Tl) detector, Study the biological effect of radiation on living cells by examine blood samples (IL-12) from different people in the study area.

MATERIALS AND METHODS

Nuclear detection and analysis system

Three technicalities have been used in the present study, the first one is gamma analysis using a Multi-Channel Analyzer (MCA) with a Thallium-Doped Sodium Iodide Detector NaI (Tl) that has been used to measure the specific activity of radionuclides in soil samples at a depth of 20 cm, taken from the selected buildings under study. The second one is Radiation Activity Detector-7 (RAD-7), which has been used to measure indoor radioactive 222Rn gas concentration in the air for the selected old buildings in different regions. The third one is an ELISA reader that has been used to measure the ratio of Interleukin-12 (IL-12) in blood from different people who have lived in the selected old buildings in different regions of Babylon governorate.

Study area

Babylon Governorate is located in the center of Iraq, south of the capital, Baghdad, 100 km away. It is the

fifth-largest governorate in terms of population in Iraq. It is located within the sedimentary plain, confined between longitudes (32.6 and 33.8) north. It is located between 43.57 and 44.12 degrees east latitude.

Location and collection of the samples

The present study was conducted on some old urban neighborhoods (old buildings) in Babylon governorate (Iraq), which includes the regions of Al-Krad, Al-Taies, Al-Jabbawyin, Al-Mahdia, Jubran, Al-Taaq, Al-Jammien, Al-Wardia, Al-Galadj, and Kretaa. The regions were divided administratively into seven sites for the purpose of collecting samples, which were collected randomly from each of the districts. The coordinates of the readings were determined by Global Positioning System (GPS).

Preparation of soil samples

To measure their specific activity, the soil must be free of moisture, because measuring the specific activity depends on the weight of the sample. Therefore, the samples are exposed to direct sunlight for three days to dry well, and then the soil is ground.

Detection system

The NaI (Tl) system, the detector which was used in this study, is a 3"x3" crystal. The crystal is encapsulated by an aluminum casing. This particular detector is designed with ORTEC Components, Inc., with a range of 4096 channels joined with an Analog to Digital Converter (ADC) unit.

Energy calibration for NaI (Tl) detector

It is used to calibrate the spectrum of gamma-ray standard sources of known energy and intensity, and the purpose of the multiplicity of sources is to get the spectrum of the energies used in the field of research (12).

Radiological effects of radioactivity

Radium equivalent activity (Raeq)

This index is used to obtain the sum of those activities 232Th, 238U, and 40K in (Bq/kg) and assess hazards associated with materials that contain 232Th, 238U, and 40K.

Absorbed gamma dose (Dγ)

The rate of absorbed dose of gamma rays in the air (Dγ) at 1 m high above ground can be measured using the specific activity of 238U, 232Th, and 40K according to the guidelines by UNSCEAR (UNSCEAR, 2000). Dγ in air is calculated in units (nGy/h).

Calculating the annual effective dose (AED) for radioactive 222Rn gas exposure

The AED of exposure to radioactive 222Rn gas in water and air was also calculated, which is equal to the sum of dose equivalents for each organ or tissue in the body exposed to radiation, and it is a measure of risk that is compared with the permissible values of radiation exposure within its limits (13).

Measurement of radioactive 222Rn gas

The reagent must be disinfected with fresh air for 10 minutes by attaching the drying unit in a closed loop with the RAD-7 detector so the outward air will pass through the desiccant and then return to the inside. It is also noted that the air flow is in the same way through the dryer.

Measurement of radioactive 222Rn gas in tap drinking water samples

As for radioactive 222Rn gas measurements in water, the RAD-H2O detector is used as an attachment to the RAD-7 detector, which is intended to measure radioactive 222Rn gas in water for a wide range of concentrations. The readings are obtained within one hour of taking the sample, and disinfection must be carried out, i.e., the humidity degree that is less than 6% must be observed. We start testing by setting the system on grab (when measuring the concentration of radioactive 222Rn gas in water, we put a pump on the grab (i.e., extract radioactive 222Rn gas from the sample).

Assay of IL-12 activity

The activity of IL-12 was assayed by measuring the strips. Briefly, 50 µl standard was added to the standard well. 40 µl sample was added to the sample wells, and then 10 µl anti-IL-12 antibody was added to the sample wells, which were mixed with the standard wells. After incubation at 37 ºC for 60 min, the plate was washed for 5 times with wash buffer.

Statistical analysis

The data were analyzed by using analysis of variance (ANOVA) using IBM SPSS software package version 20.0. Standard deviations of the mean values were calculated for each treatment. The values were also compared for the significant difference using Least Significant Difference (LSD) at $p \geq 0.05$.

RESULTS AND DISCUSSION

Comparison of the results of the current study with other studies

The means of the specific activities for ^{238}U in the current study are lower than the values determined in Iraq-Baghdad, Iraq-Nineveh, Iraq-Karbala, Iraq-Wasit, Iraq-AL-Anbar, Iraq-Basra, Jordan, India, and Turkey, according to Table 1, which compares the results of the current study's average specific activity measurements with those from previous studies. But higher than Iraq-Maysan, Iraq-Babylon, Iraq-Dhi Qar, Iraq-Muthanna, and Egypt. The means of the specific activities for ^{232}Th are less than Iraq-Maysan, Iraq-Nineveh, Iraq-Karbala, Iraq-AL-Anbar, Iraq-Basra, Jordan, India, and Turkey. And higher than Iraq-Baghdad, Iraq-Babylon, Iraq-Dhi Qar, Iraq-Muthanna, Iraq-Wasit, and Egypt. The specific activities mean for ^{40}K are lower than Iraq-Baghdad, Iraq-Dhi Qar, Iraq-Nineveh, Iraq-Muthanna, Iraq-Wasit, Egypt, and India. But higher than the values recorded in Iraq-Maysan, Iraq-Babylon, Iraq-Karbala, Iraq-AL-Anbar, Iraq-Basra, Jordan, and Turkey.

The soil type, the local geology, the region chosen, or exposure to other external influences are only a few of the reasons why the reported values have decreased or increased.

Radiological effects

Figures from (1) to (4) show the radiological effects, Ra_{eq}, D_{γ}, $H_{ex,}$ and $H_{in,}$ of the soil samples collected from the selected old urban neighborhoods (old buildings) in Babylon governorate, Iraq. In light of the radionuclides found in the soil at research locations, it can be said that no health risk poses a concern to the residents of these areas. We found that Raeq is less than the permissible limits of (370 Bq/kg), the absorbed dose rate is less than 55 nGy/h according to UNSCEAR 2000, and Hex and Hin remain less than one according to the radiation protection report when we compared the average values of the radiological effects in Table 5.3 with the value of the world average (14).

Table 1: Comparison of the present study results with previous studies

No.	Countries	Specific Activity in Bq/kg		
		^{40}k	^{238}U	^{232}Th
1	Iraq-Baghdad	393.83	22.28	10.44
2	Iraq-Maysan	277.53	12.74	26.3
3	Iraq-Babylon	293.0	15.4	6.2
4	Iraq-Dhi Qar	354.11	10.85	5.81
5	Iraq-Nineveh	326.74	41.24	21.52
6	Iraq-Muthanna	319	11.53	8.70
7	Iraq-Karbala	245.1	19.45	24.47
8	Iraq-Wasit	538.9	24.7	13.6
9	Iraq-AL-Anbar	190.720	21.152	24.219
10	Iraq-Basra	233.514	46.548	40.325
11	Egypt	405.73	15.64	14.46
12	Jordan	300	39.1	49.9
13	India	579	49.4	64.35
14	Turkey	298.6	20.8	24.95
15	Present Study	304.058	16.321	18.046

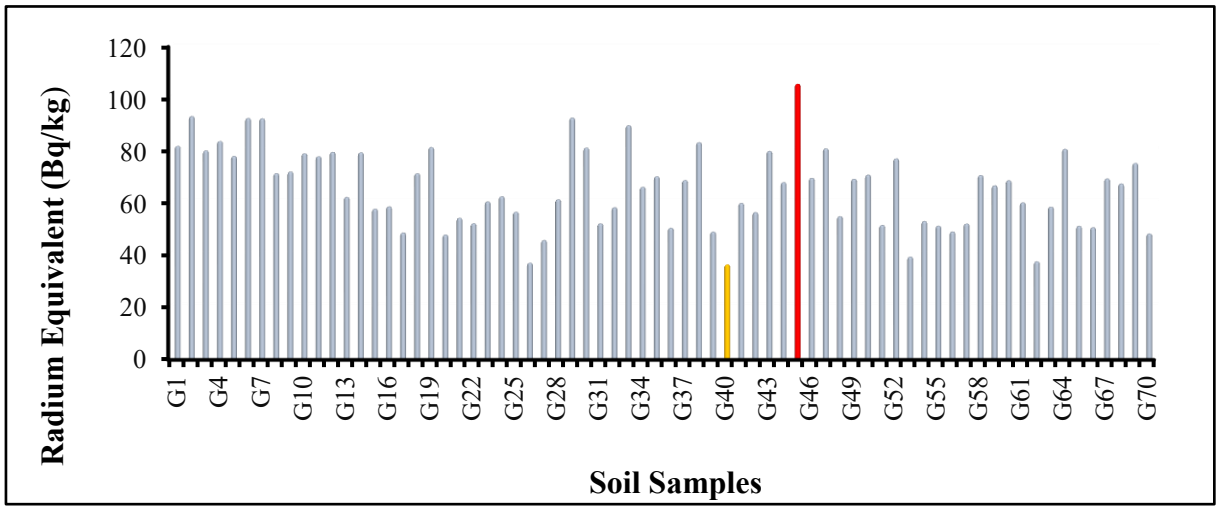

Figure 1: Radium equivalent activity levels (Ra_{eq}) for soil samples.

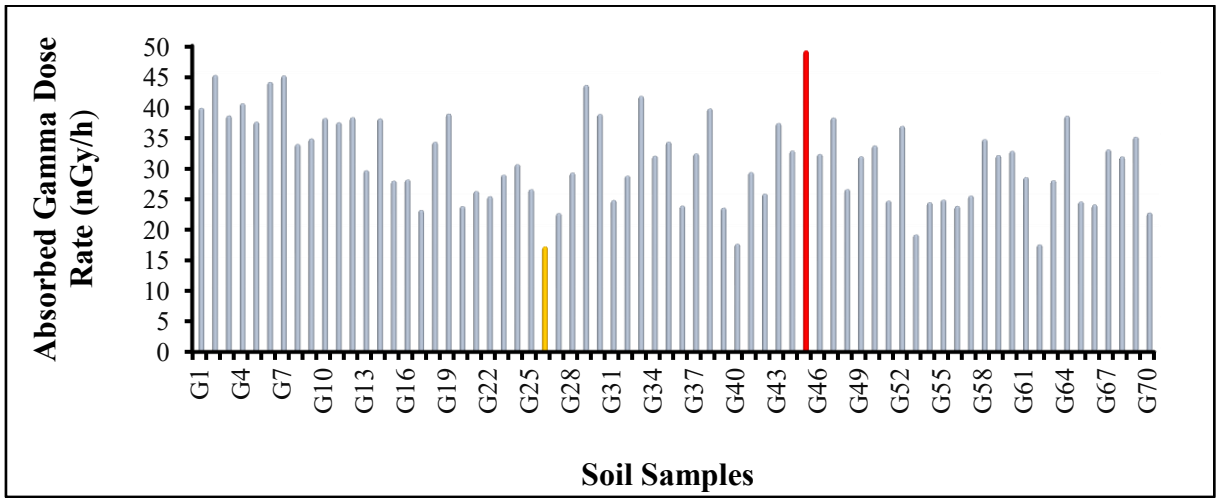

Figure 2: Absorbed γ-ray dose levels (D_γ) for soil samples.

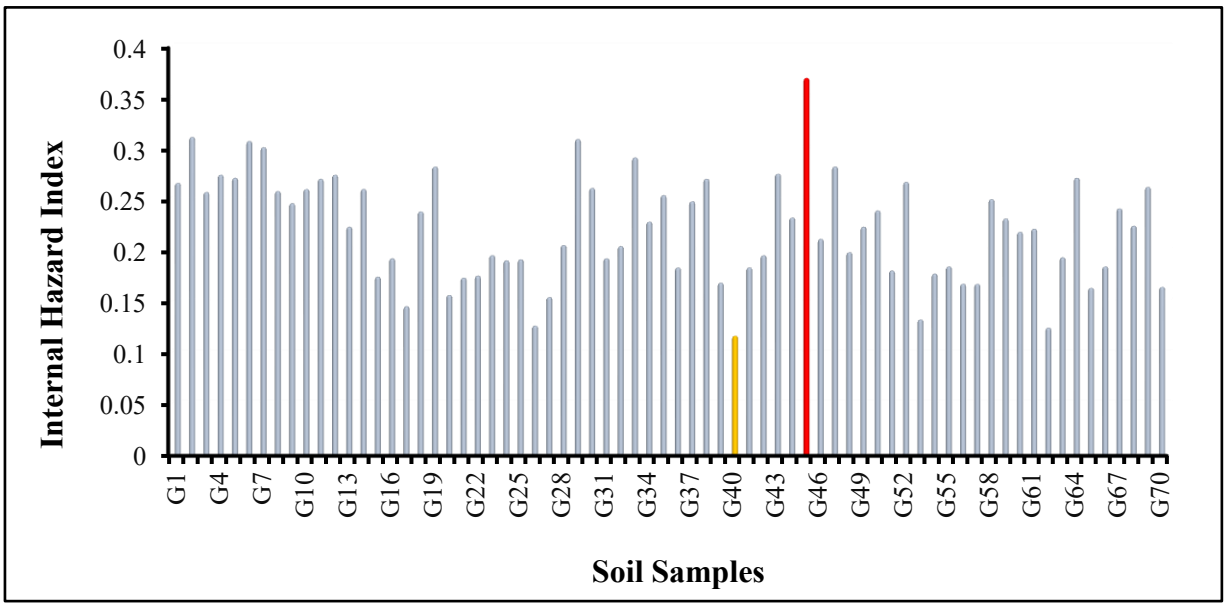

Figure 3: Internal hazard index levels (H_{in}) for soil samples.

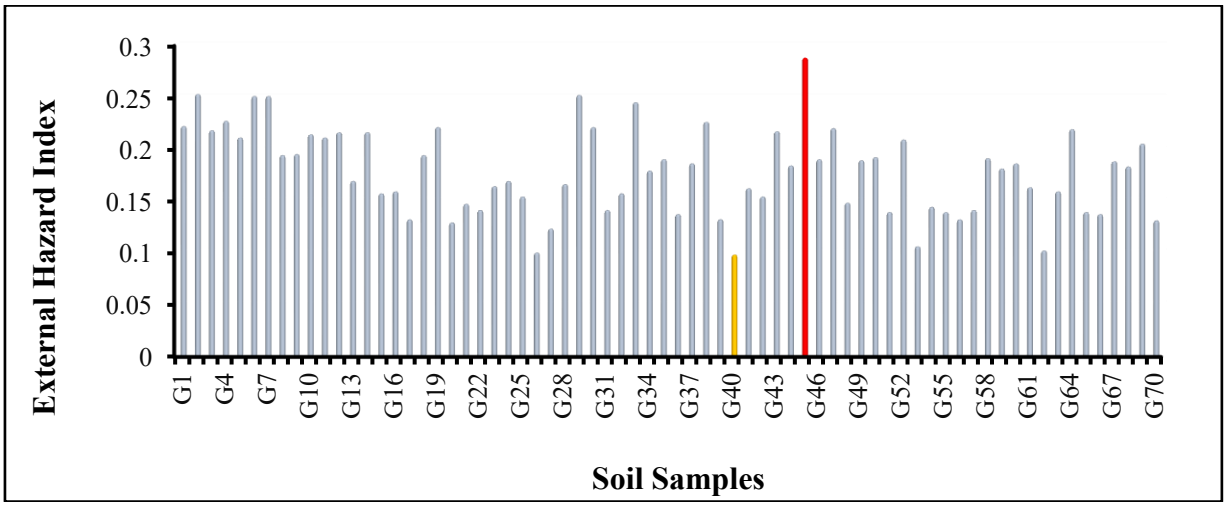

Figure 4: External hazard index levels (H_{ex}) for soil samples.

Measurement of IL-12 Activity in Blood Samples

In general, efforts to find agents that lessen the harmful effects of ionizing radiation on organ systems have increased due to the threat of harmful radiation exposure from either a device that disperses radiologic material (such as a dirty bomb) or a catastrophic malfunction similar to the reactor meltdown at the Fukushima Daiichi Nuclear Power Plant. At low doses, IL-12 has been demonstrated to be effective at reducing the negative effects of ionizing radiation on the hematological system in humans (15). It was originally discovered that ionizing radiation may seriously harm lymphocytes and the immune system. Further research revealed that even local exposure might compromise immune performance (16).

The obtained results from the old urban neighborhoods (old buildings) in Babylon governorate revealed that the correlation between IL-12 and radioactivity is close to the normal value in comparison with the control, as shown in Figure 5. The results gained are in line with those discovered by others, who discovered that several CD4+ T cell activities are radiation resistant. As a consequence, IL-12 was effective against ionizing radiation. In truth, CD4+ T helper cells can be further subdivided into Th1 and Th2 immunity-promoting cells (Mosmann and Sad, 1996). IFNc and IL-12, released by Th1 T cells, boost cell-mediated immunity, whereas IL-4, IL-5, and IL-10, released by Th2 T cells, cause strong antibody and allergy-like responses (Mosmann and Sad, 1996). Often, the cytokine milieu in a tissue microenvironment will control ensuing immunological reactions and pathology (17). The fact that radiation exposure encourages the production of cytokines in the skin as soon as a few hours after exposure is significant (18). Thus, radiation exposure frequently causes a Th1/Th2 imbalance in most tissues, including the skin (19).

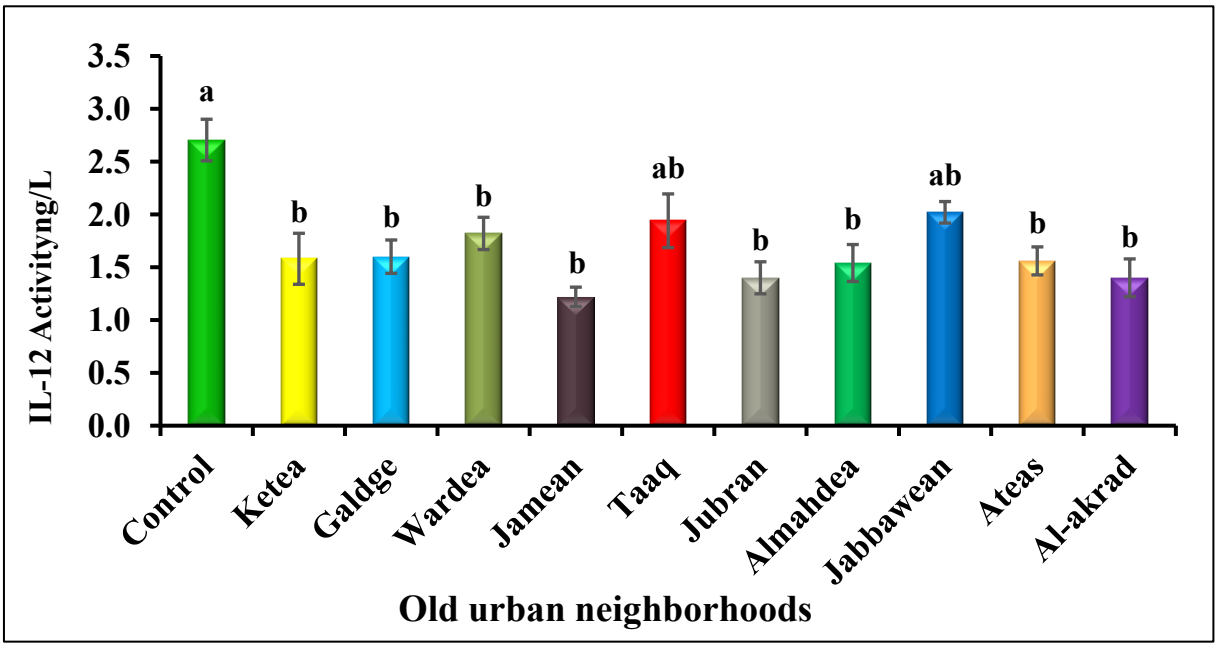

Figure 5: The effect of radioactivity on the level of IL-12 activity in the blood of some persons in the old urban neighborhoods

Conflict of interest: NIL

Funding

This research did not receive any funding.

References

1. Ahmad, N., Jaafar, M.S., Khan, S.A., Nasir, T., Ahmad, S., and Rahim, M. (2014). Measurement of radon exhalation rate, radium activity, and annual effective dose from bricks and cement samples collected from Dera Ismail Khan. American Journal of Applied Sciences, 11(2): 240-247.
2. Ahmed, A.M. and Farhan, A.O. (2022). Natural radioactivity evaluation and radiological peril in some soil specimens of AL-Taimeem area in AL-Anbar province, Iraq. Iraqi Journal of Science, 63(1): 182-190.
3. Ahmed, M.F. and Ahmed, A.B. (2007). Principles of ionizing radiation and protection prevention it. King Saud University.
4. Asgharizadeh, F., Ghannadi, M., Samani, A.B., Meftahi, M., Shalibayk, M., Sahafipour, S.A., and Gooya, E.S. (2013). Natural radioactivity in surface soil samples from dwelling areas in Tehran city, Iran. Radiation Protection Dosimetry, 156(3): 376-382.
5. Basile, L.A., Ellefson, D., Gluzman-Poltorak, Z., Junes-Gill, K., Mar, V., Mendonca, S., Miller, J.D., Tom, J., Trinh, A., and Gallaher, T.K. (2012). HemaMax™, a recombinant human interleukin-12, is a potent mitigator of acute radiation injury in mice and non-human primates. PLoS One, 7(2): 1-23.
6. Damaris O.A. (2014). Radiation level measurement in Delta State University. Science African Journal of Scientific Issues, Research and Essays. 2(11): 479-490.
7. El-Aydarous, A. (2007). Gamma radioactivity levels and their corresponding external exposure of some soil samples from Taif Governorate, Saudi Arabia. Global Journal of Environmental Research, 1(2): 49-53.
8. Hasan, A.K., Hatif, K.H. and Hamid, R.A. (2017). Measurement of natural radioactivity of soil samples collected from government departments of districts, Al-Qassim, Babylon, Iraq. Asian Journal of Research, 8(8): 3-18.
9. Kaiser, S. (1999). Radiological protection principles concerning the natural radioactivity of building materials-Radiation Protection 112. European Commission, 1-16.
10. Lei, R., Zhao, T., Li, Q., Wang, X., Ma, H., and Deng, Y. (2015). Carbon ion irradiated neural injury, induced the peripheral immune effects in vitro or in vivo. International Journal of Molecular Sciences, 16(12): 28334-28346.
11. Mosmann, T.R. and Sad, S. (1996). The expanding universe of T-cell subsets: Th1, Th2, and more. Immunol Today, 17: 138-46.
12. Muller, K. and Meineke, V. (2007). Radiation-induced alterations in cytokine production by skin cells. Experimental Hematology, 35(4): 96-104.
13. Najam, L., AL-Jomaily, F., and AL-Farha, E. (2011). Natural radioactivity levels of limestone rocks in northern Iraq using gamma spectroscopy and nuclear track detector. Journal of Radioanalytical and Nuclear Chemistry, 289(3): 709-715.
14. Papadopoulos, A., Christofides, G., Koroneos, A. and Poli, G. (2013). Concentration of 238U and 232Th among constituent minerals of two igneous plutonic rocks exhibiting elevated natural radioactivity levels. Journal of Radioanalytical and Nuclear Chemistry, 298(1): 639-650.
15. Park, H.R. and Jo, S.K. (2011). Lasting effects of an impairment of Th1-like immune response in γ-irradiated mice: A resemblance between irradiated mice and aged mice. Cellular Immunology, 267(1): 1-8.
16. Quindos, L.S., Fernandez, P.L., Soto, J., Rodenas, C. and Gomez, J. (1994). Natural Radioactivity in Spanish Soils. Health Physics, 66(2): 194-200.

17. Saad, M.H., Tamboul, J.Y., and Yousef, M. (2014). Evaluation of natural radioactivity in different regions in Sudan. Journal of American Science, 10(2): 14-18.
18. Salman, E.F., Muttelab, M.K., and Manii, J.K. (2019). Assessment of radioactivity levels and its associated radiological hazards in soil of Babylon governorate middle of Iraq. Journal of Physics: Conference Series, 1234(1): 012017.
19. Santawamaitre, T., Regan, P.H., Bradley, D.A., Matthews, M., Malain, D., and AL-Sulaiti, H.A. (2010). An evaluation of the level of naturally occurring radioactive material in soil samples along the Chao Phraya river basin. Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, 619(1-3): 453-456.