Assessment of Environmental Gamma Radiation (Outdoor and Indoor Spaces) in the Region of Bandar Abbas Gachine

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ABSTRACT

Background: Ionizing radiation is present in all environment of the Earth's surface, beneath the Earth and in the atmosphere. Human beings are exposed to external radiation from their surroundings naturally and also to internal radiation from food, water and air they consume. Then, it is important to measure and develop knowledge about radiation.

Objective: This study is designed to evaluate the risks of radiation outdoors and indoors and in hot spring in Gachine area of Bandar Abbas.

Materials and Methods: The device used in this cross sectional study was environmental radiation surveymeter. Indoor gamma radiation in Gachine area was carried out inside 115 dwellings. Measurement for hot spring waters was carried out at one meter above water level. Dose rates were recorded for an hour.

Results: Our results indicate the outdoor dose rate gamma radiation in Gachine area is higher than the global mean dose rate. Moreover, Gachine Bala has the highest outdoor gamma radiation (78.87 nGy/h) and Gachine Paien has the lowest gamma background radiation (71.62 nGy/h).

Conclusion: This study demonstrates that indoor mean dose rate of gamma radiation in this area is higher than the global mean dose rate. Estimated indoor mean dose rates were for Gachine Paien (110.58 nGy/h), Gachine Bala (111.83 nGy/h), Ship industry dwelling (109.30 nGy/h) and Jamal Ahmad (107.84 nGy/h). The highest dose rate above hot spring was obtained from Chostaneh (1320 nGy/h).

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Keywords

Hot Springs; Radiation, Ionizing; Gamma Raysl

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Introduction

Human concerns regarding the stochastic effects of ionizing radiation of natural radionuclids are increasing. Natural radionuclids are widely distributed in the Earth's crust, and they are strongly influenced by the geological situation. Environmental exposures can be divided into two categories: internal radiation exposure exists from radon, and environmental gamma radiation exists from the cosmic and the Earth's radiation [1].

The people global annual mean exposure to natural radiation sources is 2.4 mSv per year which is almost 1 msv of it caused by radon and its products. Also, the amount of environmental exposure through food and water is equal to 0.06 mSv per year. Therefore, spatial variation in exposure is significant [2].

As we said, background radiation due to the earth's surface (external) consists of two parts: cosmic radiation and the radionucleotides that exist in the earth's crust. Mainly, the radionuclides in the crust were made in the early stages of solar system origination. The main elements in their natural environmental radioactivity include uranium, thorium and potassium. General studies on natural background radiation is important for several reasons. The study of the atmosphere and internal changes in atmospheric concentrations of radon has been observed in several worldwide laboratories, and these changes depend on difference between the origins of air masses, atmospheric conditions and the plant. Therefore, this is a general fact that natural radiation depends on the geographic and geologic area. Much research has proved that natural radionuclid emissions are associated with the mineral composition of the soil. In addition, knowledge of natural radioactivity could determine the age of the Earth using the radioactive decay of ^{235}U to ^{238}U and ^{206}Pb to ^{207}Pb. Another advantage of the knowledge about natural radioactivity is the fact that it is a good indicator of environmental pollution. Therefore, it is very important and sensitive to determine natural radiation and radioactive because the man-made pollution and natural radioactivity are different [3]. Given the importance of the issue and citing preliminary studies in the region of Bandar Abbas Gachine, high level of natural background shows that it is due to radon (^{222}Rn) and U-238 in the region [4]. In addition, there are uranium mines in this area which caused extensive studies that we conduct in many other places of the outdoor and indoor spaces, especially in the area of residential houses and hot springs to have information like other points of universe in order to evaluate the risks due to radiation. In recent years, several studies in this area to assess natural background radiation are performed in Iran and other countries, some of them are mentioned below.

Iran

Some studies to estimate the background radiation were performed in the city of Mashhad in 1997 by M. Bahraini Toosi and MH Arooji. The mean dose rate was reported 0.091 µSv/h for the city of Mashhad, and the highest level radioactivity to the hot springs and mineral were reported 0.870 µSv/h related to hydrothermal Shahin springs [5]. In the studies perfomed by M. Bahraini Toosi and Ahmad sadegh in 1999 in Azerbaijan, the mean dose rate environment for the cities of Tabriz and Uromia at outdoor space and indoor space estimated 114 nSv/h and 147 nSv/h, respectively.

In addition, the background radiation in Sareyn hot spring is evaluated 165 nSv/h [6]. In researches in 2003 to assess the environmental gamma radiation in towns, hot springs and mineral province were conducted by M. Bahraini Toosi and Ahmad Aghamiri. The highest and lowest of gamma radiation in outdoor areas were 205 nSv/h and 68 nSv/h for Rineh and Noshahr cities, respectively. Moreover, the most radioactive levels in mineral and hot springs of Talysh neighborhood in Ramsar were 6212 nSv/h, and the lowest radioactivity of mineral was 61 nSv/h for water Qrmrz in Neka [7].

Other Countries

Nigeria

In 2003, in a study the environmental gamma dose rate in the delta region by A.M. Arogunnijo et al. was measured. In this study, Gamma spectrometry device was performed on the territory of 32 stations in which the external gamma dose rates in air due to existence of ^{40}k, ^{238}u and ^{232}Th were estimated 1.5±0.9 nGy/h, 6.9±1.6 nGy/h, 16.3±3.1 nGy/h in the soil, respectively. Meanwhile, the annual effective dose for the population of this region is estimated 34.6 [8].

Greece

A study to measure the background radiation in the lower atmosphere before and after the Chernobyl accident was conducted by C. Papastefanou et al. This study was coducted at different heights above sea level in Thessaloniki, Greece. A portable detector Scintillation and Surveymeter Guiie-pie ionization chamber device were used in this study. Results of dosimetery showed that average amount of background radiation at the surface of the earth before the Chernobyl accident was 87 nGy/h that 55 nGy/h was related to the Earth's radiation, and the cosmic radiation was 32 nGy/h.

Whereas after the Chernobyl accident the amount of background radiation due to the loss of radioactive materials suspended in the atmosphere with a high half life deposit into the earth had doubled [9].

Swiss

To evaluate courses from external sources in the population of Switzerland in 2001 by L. Rybach and colleagues researches were conducted in outdoor space where mean dose was estimated 147 nGy/h [10].

Material and Methods

Equipment used for this cross sectional study, includes apparatus Environmental Radiation Meter Type 6-80, which is composed of the following components: 1. Geiger Muller tube (GM) model for Mc-71. 2. Wire interface that is connected to the device by the Geiger-Muller tube. 3. A number tripod 4. clamp to hold the tube on a tripod; this device includs digital and analog displays in which the digital displays the number of comments at an arbitrary selection giving the time, and analog displays the dose rate in air in real-time according to the nGy/h determined to us. To conduct this study and to determine the dose rate measurements in the outdoor and indoor Gachine, various outdoor area and 115 homes were performed in different areas of Gachine. After station selection, dosimeters were placed on a tripod at a height of one meter from the ground or water level (in the hot springs), and every minute for an hour was determined and then by using the amount of dose received, the mean dose rate was determined and recoreded.

Results

Table 1 shows mean absorbed dose rate in different regions of Gachine outdoor. According to this table, it can be seen that the mean dose rate outdoor is estimated in Gachine Paien 71.62 nGy/h in comparison with the global mean dose rate which is higher about 21.3%.

Table 1: Mean dose rate in various areas of Gachines outdoor space

The mean dose rate (nGy/h)	Area
71.62	Gachine Paien
78.87	Gachine Bala
74.4	Between industry dwelling to Gachine

High-dose rate for Gachine Bala is 78.87 nGy/h, that it is 33.6% higher than the global mean dose rate. Additionally, the mean dose rate for the interface between ship industry dwelling up to Gachine has been estimated 74.4 nGy/h showing 26% higher compared to the global mean dose rate.

Table 2 shows the mean absorbed dose rate indoor space in several different areas of Gachine. According to this table, it can be seen that the mean dose rate indoor space Gachine Paien was estimated 110.58 nGy/h, that it is higher about 31.64% compared to the globals mean dose rate. Also, Table 2 shows that the mean absorbed dose rate indoor space of Ga-

Table 2: Mean indoor dose rate in different areas of Gachine

The mean dose rate (nGy/h)	Area
110.58	Gachine Paien
111.83	Gachine Bala
109.3	Ship
107.84	Jamal Ahmad

chine Bala is 111.83 nGy/h, which is higher about 33% compared to global mean dose rate (Figures 1, 2 and 3).

Table 2 shows that the mean dose rate indoor residential space ship is 109.3 nGy/h, that it is increased 30% compared to the globals mean dose rate (Figure 4).

The mean dose rate indoor residential Jamal Ahmed is estimated 107.84 nGy/h that it

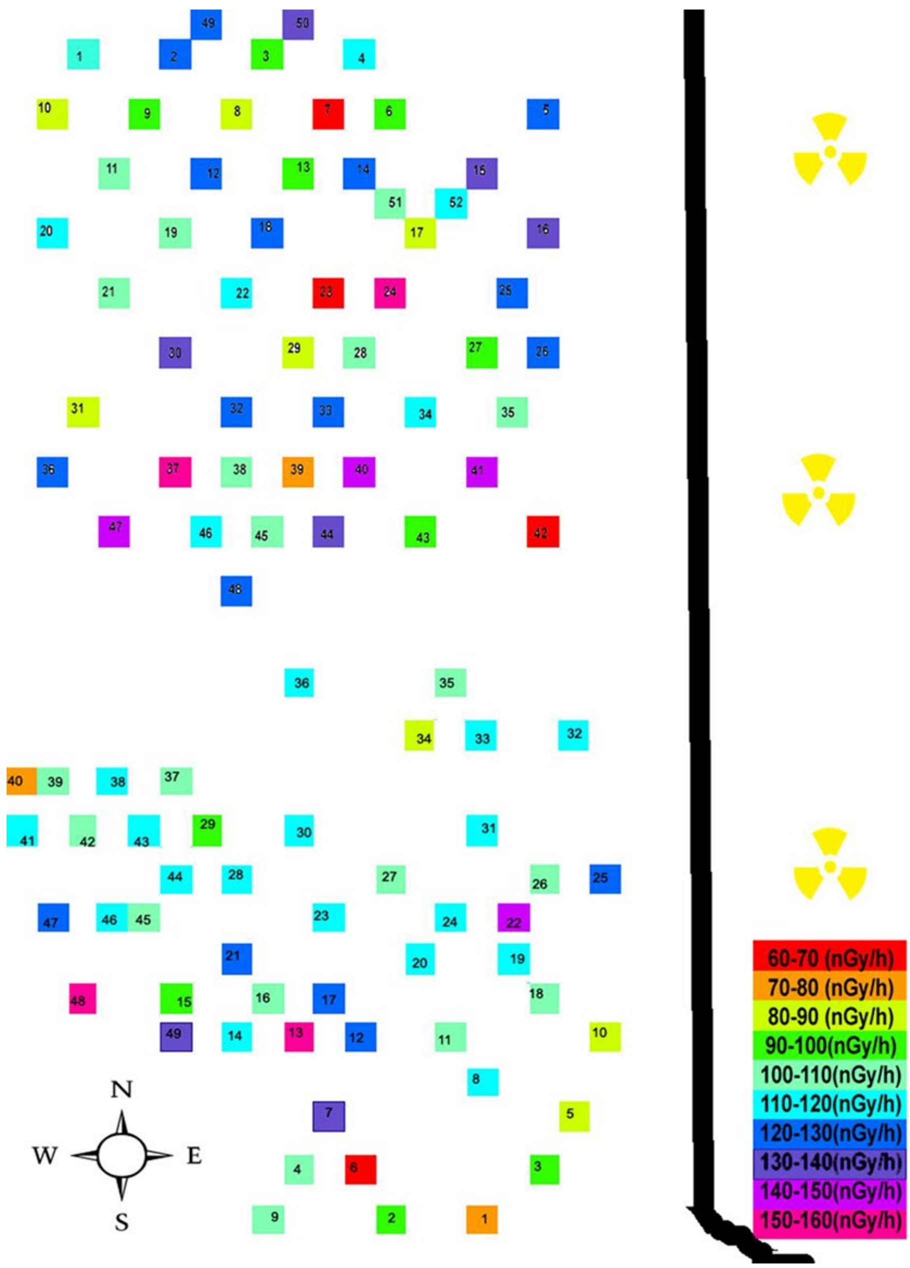

Figure 1: Location of houses measured in Gachine bala and Gachine paein.

Figure 2: Topogram of Gachine Paien

Figure 3: Topogram of Gachine Bala

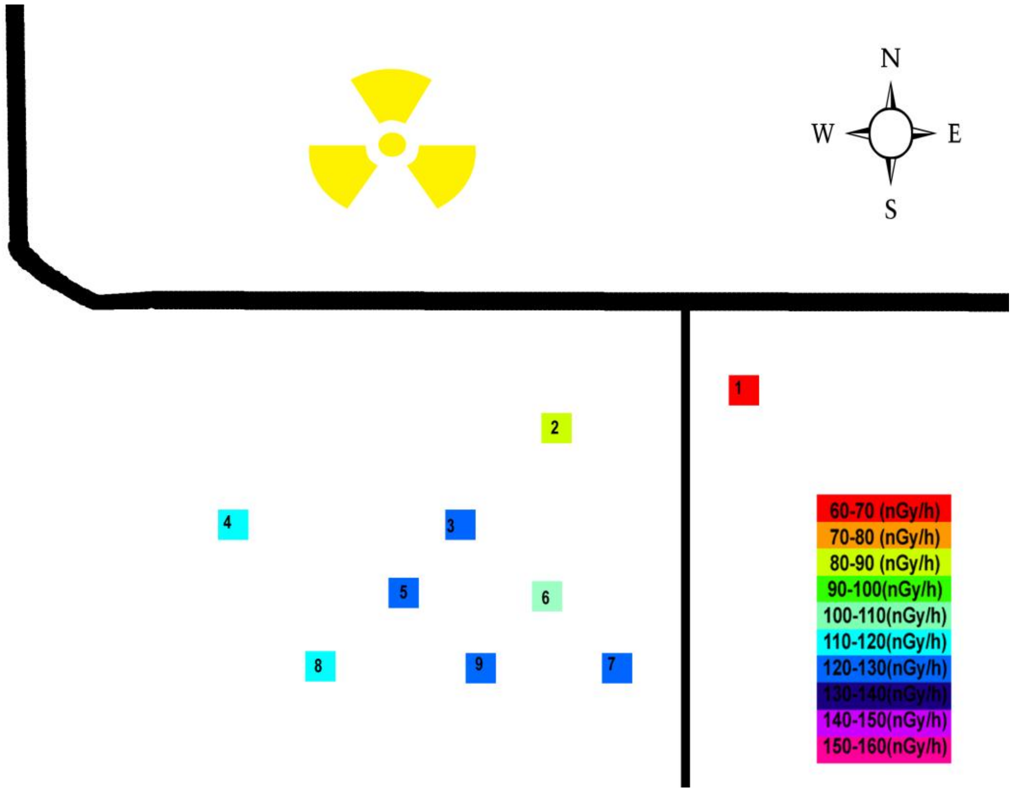

Figure 4: House location of ship industry dwelling

is higher about 28.4% in comparison with the global mean dose rate (Figure 5).

Table 3 shows the mean dose rate at a distance of one meter above the hot springs areas of Gachine. According to this table, it can be seen that the estimated dose rate of Chostaneh's first and second station are estimated 260.2 and 1319.5 nGy/h respectively, also, the dose rate in Mammadi spring is estimated 94.43 nGy/h.

Discussion

The status of radioactivity in outdoor and indoor Gachine

In Figure 6, the mean absorbed dose rate has been shown for the outdoor of different parts of Gachine, other cities of Iran, the world, regions of normal and the global mean dose rates. According to this figure, it has been shown that the mean dose rate of three regions of Gachine is higher than the global mean dose rate, and with normal regions are approximately equal (Figure 6).

Gachines mean dose rate toward Bandar Abbas (35.3 nGy/h) is doubled and the fact is that Gachines area is located on the outskirts of Bandar Abbas and the coastal line; therefore, differences are related to type and radioactive materials in the soil. The highest amount of radioactivity outdoor space is related to Gachine Bala (78.87 nGy/h) and the lowest amount is related to Gachine Paien (71.62 nGy/h).

Figure 7 demonstrates the mean absorbed dose rate in different indoor areas of Gachine and other areas. According to this figure, the mean dose rate of Gachine areas are higher than the global mean dose rate, but different cities of Iran (as shown in the diagram) are lower except Kahnooj. The mean dose rate of

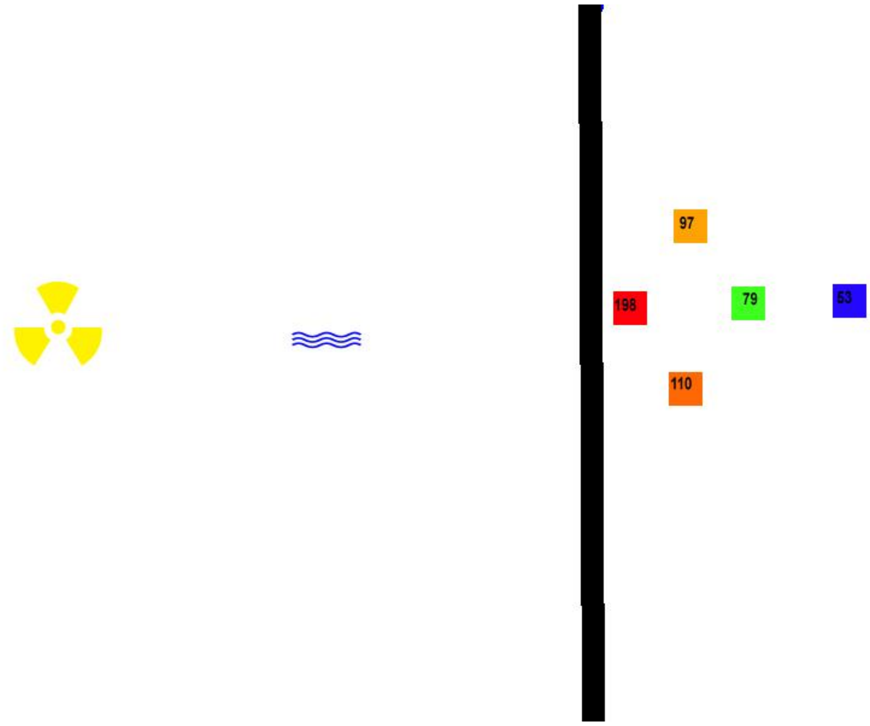

Figure 5: Location house Jamal Ahmed

Table 3: Mean dose rate of Gachine's hot spring

The mean dose rate (nGy/h)	Hot Spring
260.2	Chostaneh 1
1320	Chostaneh 2
94.43	Mammadi

Gachine Paien indoors is 110.58 nGy/h that it is higher about 54.4% than outdoor which is 71.62 nGy/h (Figure 7).

The mean absorbed dose rate iof ndoor space of Gachine Bala is 111.83 nGy/h that is about 41.8% higher than outdoor space. The mean absorbed dose rate indoor of ship industry dwelling toward its outdoor is about 109.30 nGy/h that is higher about 46.9%. The mean dose rate is 107.84 nGy/h in indoor Jamal Ahmad. The highest amount of dose rate indoor residential houses of Gachine Paien was equal to 153.23, and the lowest was 58.98 nGy/h. The highest amount of dose rate indoor of Gachine Bala is 157.35 nGy/h and the lowest is 55.63 nGy/h. The highest indoor dose rate of ship industry dwelling is 129.67 nGy/h which is related to block house, and the lowest amount of dose rate is 50.13 nGy/h related to wooden house.

Increasing the dose rate in residential block houses to wooden prefabricated houses thus justifies the construction materials usually as having radionuclides concentration of local origin which is the same concentration of soil. The highest of the indoor space dose rate for Jamal Ahmad is 198.33 nGy/h and the lowest is 53.88 nGy/h. The highest dose rate measured in total areas of Gachine related to this house that is remarkable. The annual equivalent dose of people residing in this area is equal to 1.51 mSv/y, and effective dose of them is 1.21 mSv.

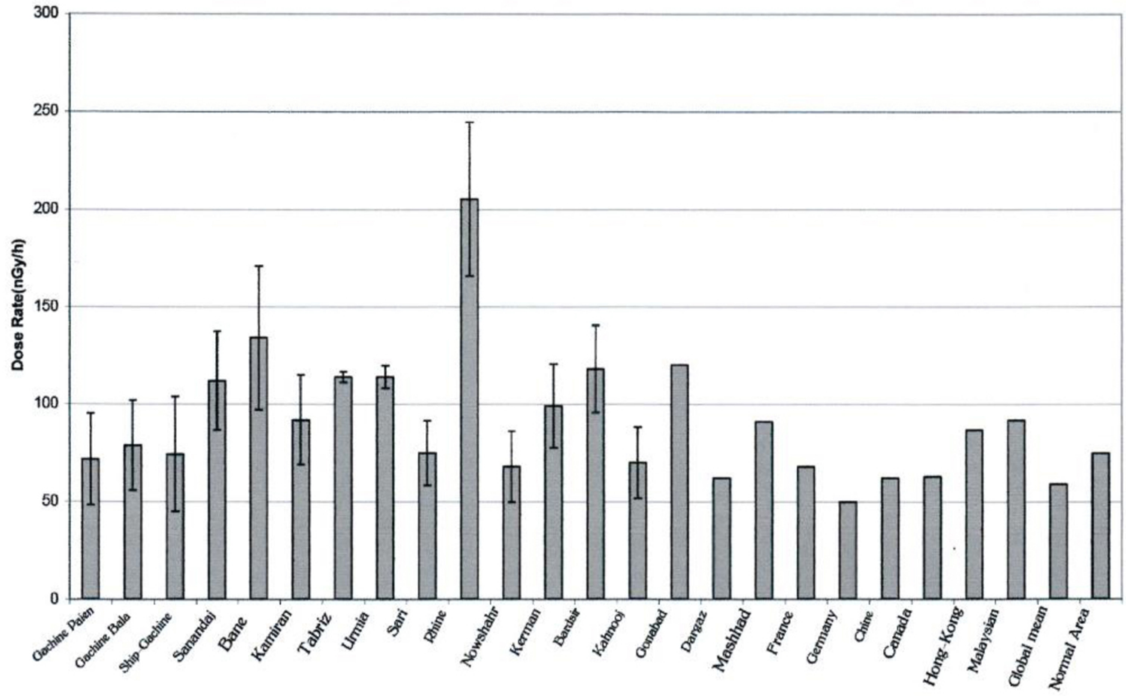

Figure 6: Comparison of mean dose rate of outdoor space in different areas of the Gachine with Iran cities and the world.

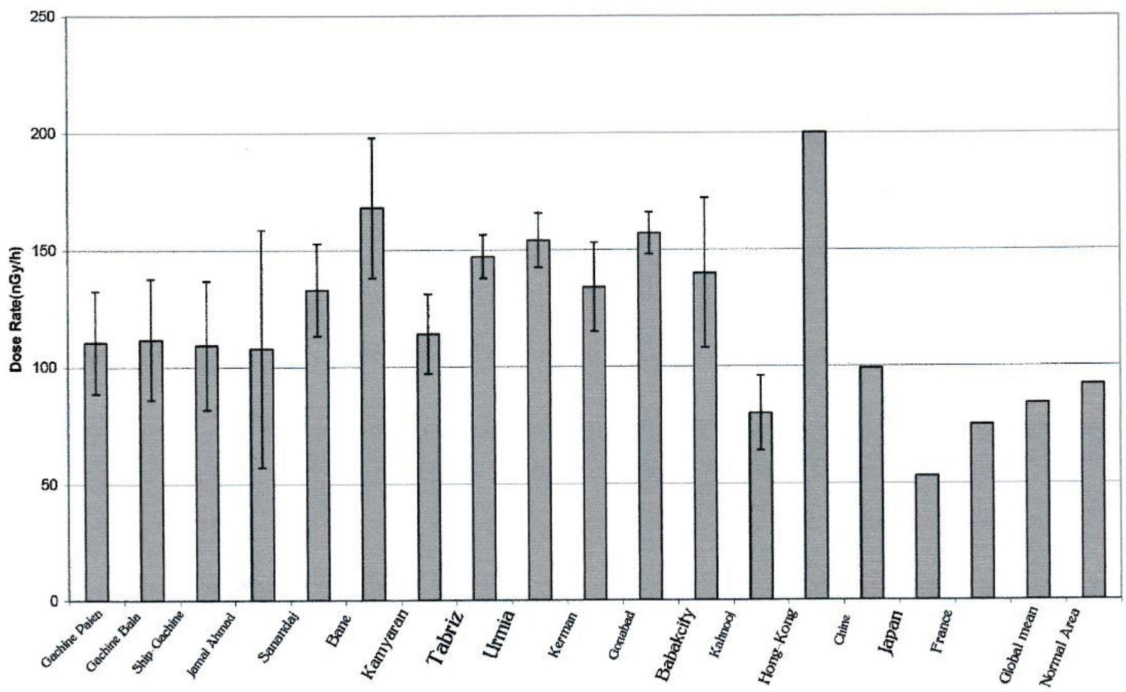

Figure 7: Comparison of different dose rates in indoor areas with other areas of Gachine.

Bone marrow dose of house resident is equal to 1.39 mSv/y, and sexual organs dose is equal to 1.41 mSv/y.

The status of dose rate in Gachine hot spring

In Figure 8 shows the mean dose rate of Gachine hot spring and some other hot spring areas of Iran. According to this figure, it can be seen that the dose rate of Chostaneh hot spring is higher than all of Iran's hot springs studied except three springs including Sepiddasht (4508 nGy/h), Talysh neighborhood (6212 nGy/h) and black water (2296 nGy/h) in Ramsar (Figure 8).

It should be noted that two stations were selected in Chostaneh spring. The first station was near spring, and the second station was the place of spring water gathering. The mean dose of the first station is estimated 260.12 nGy/h and second station is estimated 1320 nGy/h. High concentration of radioactives in this spring is due to Radium, Thorium and Uranium. Now, this hot spring following three springs of radioactive Ramsar, is the second place in Iran due to radiation levels.

Conclusion

The cause of hot springs radiation is due to passing through different layers of the earth and the dissolution of radioactive material in it.

Conflict of Interest

None

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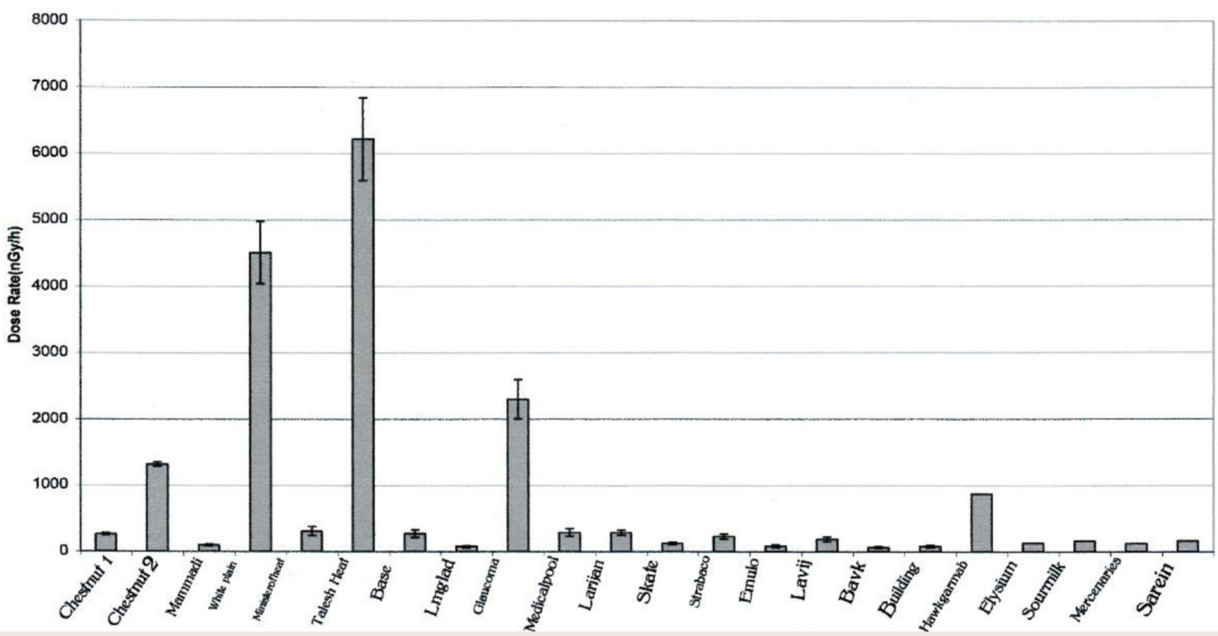

Figure 8: Comparison of the mean dose rate Gachines hot springs area with a number of hot springs in other Iranian cities.

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