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Association of Cancer Disease and ^{226}Ra Radiation Exposure in Water

KEYWORDS: Radium 226, Risk, Carcinogen

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ABSTRACT *The purpose of the paper was to study association of radium 226 in piping drinking water and cancer disease in people. This study was cross-sectional with collected 25 samples, and done by mini column method on piping water after treatment. The technique of gamma-ray measurement was applied by using HPGe gamma detector. The cancer disease patient was accessed from health center and followed them. The activity concentrations of 226Ra in drinking water samples were 2±0.5 mBq/l - 10.4±0.8 mBq/l, the maximum concentration was 10.4±0.4 mBq/l and the minimum level was 2±0.5 mBq/l. The radiation absorbed dose in air was 60 nGy/h and effective dose was 0.00055 mSv. The radiation doses to biota were less than doses received from naturally occurring radioisotopes or from manmade activities. The concentration of 226Ra was so low in the drinking water that did not cause cancer disease.*

Introduction:

Ingestion of low level of ^{226}Ra compound and extremely low dose of ^{226}Ra exposure to the general public in drinking water could not be a cause of cancer disease (1, 2). Extensive surveys in many countries of the world were taken place (3), these researches were useful due to public dose rate and to keep records in order to ascertain possible changes in the water radioactivity due to nuclear, industrial and other human activities. The low dose rate from^{226}Ra was consequently to translate only a small fraction of the cell population being exposed with the majority of cells never being exposed at all (4). Nuclear fission in connection with atomic weapons testing provided another source of water contamination (5). The exposure of chronic low dose led to several non-cancerous effects on various target systems. There were also effects on modification of cellular in the intestinal mucosa (6). When a low dose was given to people, the ability to repair DNA damage was enhanced and formation of micronuclei was decreased. However, it was necessary to study radium 226 concentrations in drinking water in south-east area; because, concern and awareness about radioactive pollution by public was raised. This study was carried out to measure the amount of ^{226}Ra in the piping drinking water and available cancer disease.

Materials and method:

Study area

The study was conducted in south –east of Zahedan city in Iran. The location of Zahedan city was 31˚ S and 70˚ E and at elevation of 180 m from sea level. The annual rainfall was 120mm. The source of drinking water was tube-storage from 160 km of Zaboul Chah Nimeh with chemical compounds such as sodium carbonate and magnesium and ferro oxide. This water was salinity and used to washing. The region was almost was barren.

Sampling

The experiment was laid on 25 sites. The distance between sites was 20 km. The water sampling was done in 2011-2012 from piping water after treatment. Sampling from the piping water was performed using the Standard sampling methods (7). Five samples from each region were covered in this way and the total number was 25 samples. The samples were properly marked; cataloged and brought to physics laboratory at Zahedan city, Iran for processing before analysis. The cancer patients was asked from hospitals and clinics for one year; then, followed them (table2).

Water processing

The study was cross-sectional with collecting twenty five samples from piping water in different places. Twenty five station of Zahedan city regions such as Emam Ali hospital, Elmiyeh school of Daro Al Ghoboz in Karim abad, Bou ali hospital and bus terminal area and Hemmat abad were selected as stations for water sampling. At first, drinking water was flowed from the tape for 5 minutes. Twenty five samples were provided from piping water of each station within 24 hours. One liter of the piping water was collected in a special bottle. An annual effective dose of drinking water consumption of a rate of two liters per day for 365 days was 0.1 mSv. The current annual limit for ^{226}Ra ingested through drinking water was 110mBq/L.

Experiment

After waiting for 24 hour, the concentration of ^{226}Ra in the drinking water was determined by an advanced detector which was located at atomic energy. The concentration of ^{226}Ra in the drinking water was determined by an advanced detector which was located in Iranian atomic energy (table1). The technique of gamma ray measurement was applied for determination of radioactivity of samples. The system consisted of an HPGe detector with relative efficiency 30%. The resolution of the system was 2 kev at 1332.5 kev peaks of Co-60. Time of reading samples was 20000 seconds. Analysis of data was done with using software of SPSS. Activity concentration was determined. Dose rate at one meter above the ground surface was equal Gamma absorbed dose in air outdoors and could be calculated by below formulae:

$$D = A_C \times C_F$$

$$H_e = D \times T \times F$$

Where D was the dose rate in nGy/h , A_c was he activity concentration in Bq/kg and C_F was dose conversion factor in nGy/h to Bq/kg (absorbed dose rate in air per unit of activity concentration). The dose conversion factor was from the report. H_e was effective dose (μSv/y, D was dose rate in nGy/h, T was outdoor occupancy time factor0.2 x 24 x 365.25 day. and F was a converting factor for absorbed dose to effective dose (0.7×10^{-3} μSv per nGy).

Results:

The maximum and minimum levels of available radium-226 in drinking water were 10.4± 0.8 mBq/L and 2± 0.5 mBq/L in point 1 located in city center and point 2 in south of city respectively (table1). There was 5.3±0.4 mBq/L, 5±0.4 mBq/L and 5.9±0.5 mBq/L levels of available radium-226 between these stations (table1). Cancer disease person who

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drank from water for one year was shown according to health center (table 2). The radiation absorbed dose in air in the region was 0.00055 nGy/h and effective dose 0.1mSv. Analysis showed less concentration of chemical elements compounds in drinking water.

Discussion:

The radiation exposure of ^{226}Ra at 10.4± 0.8 mBq/L was less for mutagenic and carcinogenic risk (8). The standard dose showed the radiation dose level for drinking water was 0.00055 nGy/h and 0.1mSv, which was equivalent to approximately one third of the dose from naturally occurring radium 226 in drinking water. Therefore, carcinogenic health effects of radium 226 with 10.4± 0.8 mBq/L was not possible to be occurred, and so it was a safe standard for human health (9, 10). Concentration of radium-226 at 10.4± 0.8 mBq/L was compared to the natural variation in background radiation due to changes in cosmic radiation levels. An annual exposure resulting from the consumption of 2 L of water per day, containing radium-226 at a concentration of 10.4± 0.8 mBq/L were 0.00055nGy/h and 0.1mSv. An increase in annual dose, as a function of elevation, was approximately 1.0 mSv per 20,000 ft (11). Lowers a limit seven orders of magnitude, lower detectable biological too, and indistinguishable from natural variation in background radiation, was not a reasonable level to a safety regulation. In regions Yangjiang, China, the average annual effective dose of natural background radiation was more than 6.4 mSv and there was no significant increase in cancer incidence (12, 13). Another region with naturally high levels of background radiation ranging from 4–70 mGy/year study of cancer incidence in Kerala, India revealed no excess cancer risk (14, 15). Radium-126 was the largest contributors to radiation doses received by the human being. Programmers maker in drinking water consumption knew biological consequences. Low dose exposures have thresholds below which there were no observable detrimental effects. This radioisotope was carefully managed by Iranian facilities in order to minimize radiation exposure to the public or environment to prevent cancer disease. A threshold based system, which considers the effect of dose rate, was more appropriate in radiation risk estimation and protection policy.

CONCLUSION:

The carcinogenic potential effects of radium -226 with very low dose at a concentration of 2 -10 mBq/L was considered insignificant of drinking water.

Table1. ^{226}Ra concentration in drinking water sources of Zahedan - sistan & blouchestan

station ^{226}Ra	Average doses in five points of west of city	Average doses in five points of north of city	Average doses in five points of centre of city	Average doses in five points of south of city	Average doses in five points of east of city
Average concentration (mBq/l)	5±0.4	5.9±0.5	10.4±0.8	2±0.5	5.3±0.4

Table2. Cancer disease patients in regions consumed piping drinking water with ^{226}Ra in Zahedan - Sistan & Blouchestan

location	in west of city	in north o city	in centre of city	in south of city	in east of city
people with Cancer	15	25	10	5	25

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