Original Article

Assessment of gamma-dose rate in city of Kermanshah

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ABSTRACT

Introduction: Environmental natural radiation measurement is of great importance and interest especially for human health. The induction of genetic disorder and cancer appears to be the most important in an exposed population. **Materials and Methods**: Measurements of background gamma rays were performed using a mini-rad environmental survey meter at 25 different locations around the city of Kermanshah (a city in the west of Iran). The measurements were also performed at two different time of day one in the morning and the other in the afternoon. At each location and time measurements were repeated for five times and the mean was considered as the background dose at that location. **Results and Discussions:** Comparison between the measured results in the morning and afternoon has not shown any significant difference ($P > 0.95$). The maximum and minimum obtained results were 2.63 mSv/y and 1.49 mSv/y, respectively. From the total measurements at 25 sites mean and SD background radiation dose to the population is 2.24 ± 0.25 mSv. **Conclusion:** The mean radiation dose to the population is about 2.5 times of the world average total external exposure cosmic rays and terrestrial gamma rays dose reported by UNSCEAR.

Key words: Background radiation, environment radiation, ionizing radiation, low level radiation

INTRODUCTION

The process of ionization in living matter necessarily changes atoms and molecules, at least transiently, and may then damage cells. The cellular damage may prevent the cell from surviving or reproducing or performing its normal functions.[1]

Damage to deoxyribonucleic (DNA) in the nucleus is the main initially event by which radiation cause long-term harm to organs and tissues of the body.[1-3]

The follow-up of radiation cancer induction to tissues demonstrated that excess cancers continue to occur at long time after radiation exposure.[1,4]

The sources that expose living organism in daily work are cosmic rays that come from outer space. Terrestrial radionuclide are those that occur in the Earth's crust, in building materials and air, water and in the human body itself.

Studies of background radiation are of great importance. They are measured in many countries.[5-22] The level of natural exposure varies around the globe, usually by a factor of about 3.[22,23] At many locations, however, typical levels of natural radiation exposure exceed the average levels by a factor of 10 and sometime even in some places known as hot areas by factor of 100.[23] Some of the exposures are fairly constant and uniform for all individuals everywhere, for example, the dose from ingestion of ^{40}K in foods while other exposure such as cosmic rays depending on location. It is higher at higher altitude.[23]

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Exposure from natur al radioactive materials also can vary widely depending on the localization of the area. The annual worldwide per caput effective dose is determined by adding the various components, as summarized in Table 1.[23]

The mean annual global per caput effective dose due to natural radiation sources is about 2.4 mSv.[23] However, the range of individual dose is wide as it is shown in Table 1. About one third of this is due to external sources and the other two third are from internal sources.[22,23] It is estimated that dose from external radiation can rise by about 1.5 and from internal radiation about 2.5 times of the above figures. [18,23]

Places with high background exposure have been studied extensively. Examples are: Brasilia, some parts of India, Ramsar in Iran, etc.[8-15] The high level of exposure in Ramsar is believed to be due to the resolved radium in mineral waters, travertine deposits having elevated levels of thorium combined with lesser uranium.[10] There is no information about the background radiation in Kermanshah. It is the aim of this work to measure X and γ-rays background radiation during a year in Kermanshah.

MATERIALS AND METHODS

Dose rate measurements were made using a Series 1000 Mini-rad survey meter (Mini Instruments Ltd, 15 Burunham Business Park, Springfield Road, Buranham on Crouch, Essex CM0 8TE. During measurement the dosimeter was held at about 1 m above the ground surface. The locations of the measurements were chosen away from obstacles, outcrops and building whenever possible.

Measurements at each location were made at two different times of a day, one in the morning at 10 a.m. the other in the afternoon at 5 p.m. At each time measurements were repeated for five times. Each measurement was collected for 1 minute. The means were calculated and used as the measured dose at each time and locations.

A total of 25 locations were selected for the investigation. The latitudes and altitudes of the locations were determined from the information supplied by the Geographical Institute of Kermanshah. Figure 1 shows the map of Kermanshah and the geographical distribution of the selected locations for the measurements.

Table 1: The components of background radiation and their variations[23]

Source	Worldwide average effective dose (mSv)	Typical value
External exposure Cosmic rays	0.4	0.3-1 (a)
Terrestrial gamma rays	0.5	0.3-0.6 (b)
Internal exposure	1.2	0.2-10 (c)
Inhalation (mainly Radon)	0.3	0.2-0.8 (d)
Total	2.4	1-10

(a) Range from see level to high ground elevation
(b) Depending on radionuclide composition of soil and building materials
(c) Depending on indoor accumulation of radon gas
(d) Depending on radionuclide composition of foods and drinking water

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RESULTS AND DISCUSSIONS

Mean and SD of the obtained dose rate for each site and day time is calculated. The results of the calculated means of the morning and afternoon are compared using t-test. There were not significant different between the two means at 95% significant levels. The means of the total measured dose rate at each location were measured from both morning and afternoon data. They are shown in Table 2 along with altitude at that location. The obtained mean dose rate for each site in terms of altitude is also shown in Figure 2. The relation between the two parameters when best fit straight line is applied to the data of Figure 2 is:

$$\text{Dose equivalent rate} = 0.00024 \times \text{altitude} - 0.112 \quad (1)$$

This equation shows that for each 100 meter increase in altitude, equivalent dose rate increase 12%. This is slightly different from the results reported by UNSCEAR[19] which shows that for every 1500-m increase in altitude dose rate from cosmic rays increase twofold. It is also necessary to mention that these results are both from cosmic and terrestrial radiation.

The mean annual dose rate in Kermanshah is calculated

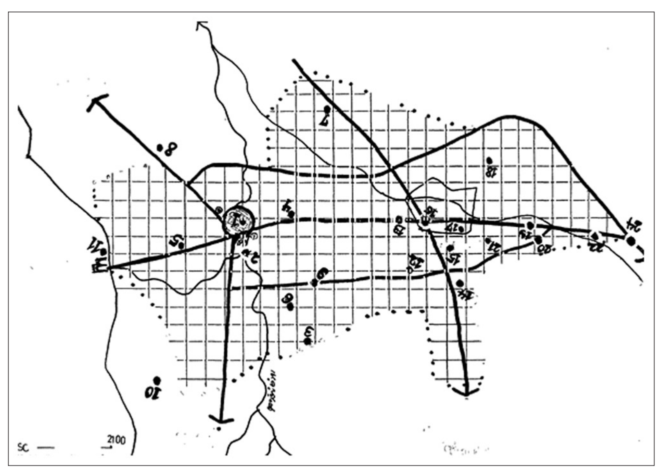

Figure 1: Kermanshah map and the locations of the measurement

Table 2: Dose equivalent (μSv/y) at different locations and at different altitude (m)

Location	Latitude	Mean
Pool Garasoo	1295	0.2
!5 Kordad Sq.	1300	0.2
Resalat Sq.	1304	0.2
Taleghani Hosp.	1309	0.2
Shirodi Bolvar	1310	0.22
Lagrizan Bolvar	1310	0.22
Kayhanshahr Sq.	1313	0.19
Komayni Sq.	1314	0.25
Nobahar Fourway	1317	0.19
School of Mewdicine	1322	0.22
Taghbostan lake	1325	0.24
Zanbagh Park	1330	0.19
Basig Fourway	1335	0.17
Jalalieh Park	1344	0.21
Kargea Sq.	1350	0.19
Azadi Sq.	1350	0.22
Taleghani Sq.	1377	0.19
Jamkaneh	1385	0.21
Jehad Sq.	1390	0.21
Fatemie Sq.	1405	0.21
Shiri Park	1415	0.27
Laleh Park	1426	0.2
Jomhori Eslami Sq.	1436	0.23
Ferdosi Sq.	1446	0.26
Bostan Kooh	1700	0.3
Mean		0.25 ± 0.029

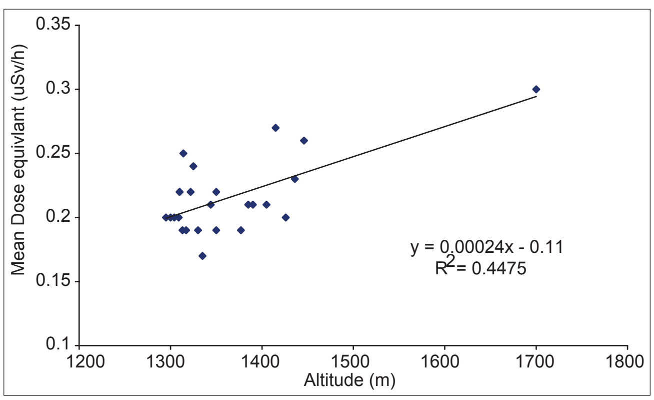

Figure 2: Mean dose equivalent rate at different altitude

from the results and is 2.24 ± 0.25 mSv. Comparing with the mean world environmental dose rate reported by UNSCEAR background radiation in Kermanshah is about 2.5 times the reported by UNSCEAR.[23]

From the results it is also clear that people living in areas with lower altitude receive slightly less radiation than dose living in higher altitudes. It is also clear that unexpected radiation background area is not seen in the Kermanshah.

About one-third of the measured values are expected to be from Cosmic rays.[23] Exposure from cosmic rays at sea level is estimated to be about 32 nGy/h which is equivalent to 0.28 mGy/y.[23] As the altitude height of Hamedan is more than 1000 meter from sea level, therefore it is expected that the cosmic rays at the city to be about 0.37 mSv/h which is about one-sixth of the measured values in this research. The difference could be form natural radioactive materials and ionizing radiation from artificial sources present in the area. It should be mentioned that exposure to individual should be less than 80% of that as people spend about 80% of their life under the ceiling.[23]

CONCLUSIONS

A total of 300 dose rate measurements were collected from 25 different locations throughout Kermanshah city to determine X and gamma radiation background dose. The relation between mean dose equivalent and altitude is according to equation:

Dose equivalent = 0.00024 × altitude-0.112

The mean annual population dose from cosmic and terrestrial radiation was 2.24 ± 0.25 mSv per year. This is about 2.5 times of the world average total radiation background reported by UNSCEAR.[5]

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