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Gamma background radiation measurement in Lorestan province, Iran

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Background: The exposure of human being to ionize radiation from natural sources is a continuing, inescapable feature of life on earth. Direct measurement of absorbed dose rates in air has been carried out in many countries of the world during the last few decades. Such investigations can be useful for assessment of public dose rates, the performance of epidemiological studies, and keeping reference-data records to ascertain possible changes in the environmental radioactivity duo to nuclear, industrial, and other human activities. ***Materials and Methods:*** The measurements of the outdoor and indoor- environmental exposures including cosmic and terrestrial components were accomplished by a portable Geiger Muller detector (RDS -110). The measurements were made during daylight from September to October 2009, in five areas within nine big cities of Lorestan province. In each area, one building was randomly selected for indoor and outdoor measurements. Measurements were made for each region and an average value was used to calculate the exposure rate from gamma background radiation. ***Results:*** The results showed the Maximum and minimum outdoor dose rates as 166±44 and 65±8 $nSvh^{-1}$ in Borujerd and Pol-e- dokhtar, respectively. The average of outdoor dose rates was determined 113±26 $nSvh^{-1}$. Also the maximum and minimum values of indoor dose were 157±52 and 74±14 $nSvh^{-1}$ in Borujerd and Pol-e-dokhtar, respectively. The average indoor dose rates were determined as 119±27 $nSvh^{-1}$. ***Conclusion:*** The average annual effective dose for gamma background radiation in Lorestan province has been 0.72 mSv, with the range of 0.3– 0.6 mSv which was more than the global value (0.48 mSv). A poor correlation coefficient between was observed altitude and absorbed dose rates. **Iran. J. Radiat. Res., 2011; 9(2): 89-93**

Keywords: *Terrestrial radiation, average annual effective dose, cosmic rays, Lorestan province.*

INTRODUCTION

Environmental radioactivity measurements are necessary for to determine the background radiation level due to natural radioactivity sources of terrestrial and cosmic origins. The terrestrial component is due to the radioactive nuclides that are present in air, soil, rock, water and building materials in amounts that vary significantly, depending on the geological and geographical features of a region. The cosmic radiation originates from space as cosmic rays whose contribution to background changes mainly with elevation and latitude. In addition to these natural sources, the level of background radiation in a region is affected by man-made sources such as those from nuclear activities and accidents (1, 2).

There are several international studies reported for measurement of terrestrial gamma radiation levels to assess the effective dose to the population (3,4). The studies were performed both in outdoor and indoor areas. The global dose rate value for outdoors is 59 $nSvh^{-1}$ with the range of 18-93 $nSvh^{-1}$. The same value for inside dwellings is 84 $nSvh^{-1}$ with the range of 20-200 $nSvh^{-1}$. In Asia, the maximum measured outdoor dose rate is found in Malaysia, whereas the maximum indoor value is seen in Hong Kong and Iran. The mean values are 200 and 115 $nSvh^{-1}$, respectively, which reflects the wide use of stone or masonry materials in buildings in these countries (3).

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Many studies in the field of gamma background radiation were performed in different cities in Iran [5 – 9]. All these studies showed that the average outdoor dose rate in Mashhad, Yazd, Isfahan, Oromeih and Tabriz are greater than the reported mean value by UNSCEAR-2000 [3]. Lorestan province consists of 9 big cities with an area of about 28294 Km^2 (46°51'-50°3'E and 32°37'-34°22'N). The province is mountainous, part of the Zagros chain, from northwest to southeast of Iran. The highest point of the province is Oshtoran Kooh peak at 4,050 m. The low-lying area in the southern part of the province is approximately 500 m above sea level. The depositional environment and tectonic history of the rocks have been conducive to the formation and trapping of petroleum, so the Zagros region is an important part of Persian Gulf oil reservoir. Therefore, this study was carried out to provide a map of ambient gamma background radiation using a Geiger Muller detector at populated areas of Lorestan province to estimate annual effective dose of residents in these areas.

MATERIALS AND METHODS

The measurements were accomplished by a G.M detector (RDS-110), during day-light since September to October 2009.The G.M detector was calibrated by Iran Secondary Standard Dosimetry Labaratory (ISSDL).The gamma background radiation measurements were performed both indoor and outdoor in five areas (north, south, west, east and the center) in nine cities of Lorestan province including Khorram Abad (1150 m), Borujerd (1500 m), Aligoudarz (1250 m), Azna (1100 m), Doroud (1050 m), Alashtar (1250 m), Kouhdasht (810 m), Noor Abad (1420 m) and Pol-e-dokhtar (790 m) (figure 1). In each area one building was selected randomly for indoor and outdoor measurements. All buildings were one story with similar masonry materials. The outdoor radiation measurements were performed by placing the detector at least six meters away from each building or wall, and one meter higher than the ground in order to reduce their effects on the radiation field. The indoor radiation measurements were also performed by placing the detector one meter higher than the ground in the side buildings. The values of the outdoor and indoor absorbed doses were calculated by using occupancy factors (representing the weighted average for the population of these regions) of 20% and 80%, respectively. The values of annual effective dose were determined based on the equivalent dose. Since radio nuclides decay and cosmic radiation fluency varies slightly in time, the total exposure time of 1 hour was considered in each measurement. The annual effective dose was determined as follows:

Indoors: $D_{in} \times T \times OF \times$ the conversion coefficient
Outdoors: $D_{out} \times T \times OF \times$ the conversion coefficient

Where D_{in} and D_{out} are the mean absorbed dose rates in air indoors and outdoors, T, the time converter from hour to year (8760 h), OF, the Occupancy Factor, that is the fraction of time spent indoors and outdoors, which are 0.8 and 0.2, respectively. The conversion coefficient (0.7 Sv Gy^{-1}) is reported by UNSCEAR 1993 to convert absorbed dose in air to the effective dose received by adults. A topographic map of the

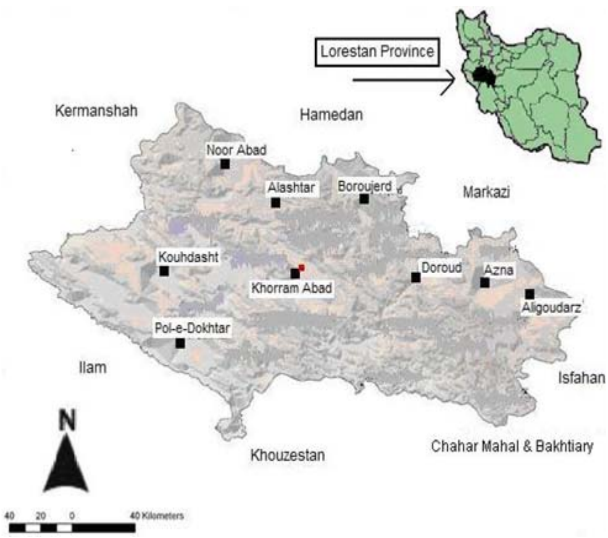

Figure 1. The map of Lorestan province and the selected regions.

studied regions was obtained from Civic Engineering Organization of the Province shown in figure 1.

RESULTS

The absorbed dose rate in air, including outdoor and indoor gamma background radiation in 9 cities of Lorestan province is shown in table 1. Each of the values is mean plus standard error of the five measurement areas of these cities. The measurements showed that the Maximum and minimum outdoor dose rates were 166±44and 65±8nSvh^{-1} in Borujerd and Pol-e-dokhtar, respectively. The average of outdoor dose rates was determined 113±26 nSvh^{-1}. Also the maximum and minimum values of indoors were 157±52 and 74±14 nSvh^{-1} in Borujerd and Pol-e-dokhtar, respectively. The average of indoor dose rates was determined as 119±27 nSvh^{-1}. The average ratio indoors to outdoors dose rate was 1.06 in Lorestan province.

Figure 2 shows the indoors and outdoors annual effective dose rate in cities of Lorestan Province. As seen, the maximum and minimum outdoor effective dose rate were 1.01±0.27 and 0.4±0.05 mSvy^{-1} in Borujerd and Pol-e-dokhtar, respectively. Also the maximum and minimum indoor effective dose rates were 0.95±0.31 and 0.44±0.08 mSvy^{-1} in Borujerd and Pol-e-dokhtar, respectively. The annual effective dose for adults in Lorestan province was calculated as 0.72 mSv as follows:

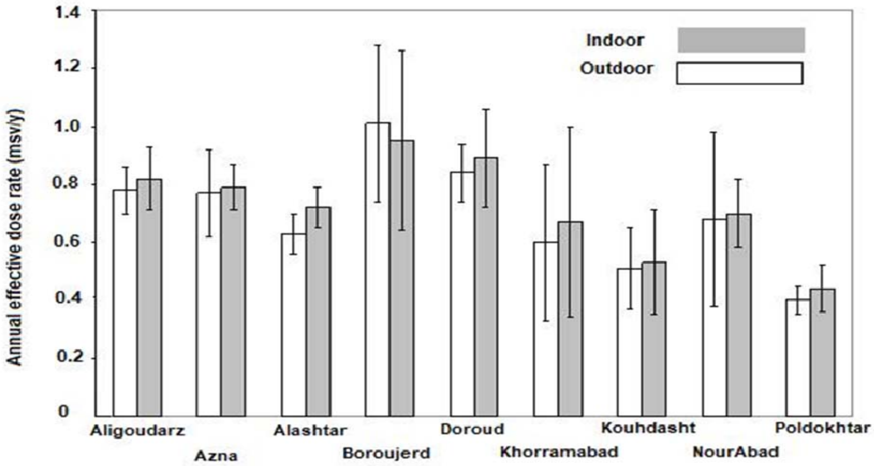

Figure 2. Indoors and outdoors effective dose rates in cities of Lorestan Province.

Table 1. The outdoors and indoors values of dose rates due to gamma background radiation in the selected regions of Lorestan Province (nSvh^{-1}).

City	Outdoor mean Dose Rate± SD	Range	Indoor mean Dose Rate± SD	Range	Ratio indoors to Outdoors
Borujerd	166±44	90-290	157±52	90-380	0.94
Doroud	137±16	60-230	148±28	80-250	1.08
Aligoudarz	129±14	70-210	136±19	70-310	1.05
Azna	127±25	80-230	130±13	90-260	1.02
Noor Abad	112±49	80-180	117±20	60-180	1.04
Alashtar	103±12	60-170	119±12	70-180	1.15
Khorram Abad	97±45	10-230	110±54	50-200	1.13
Kouhdasht	83±23	60-170	87±31	40-270	1.04
Pol-e-dokhtar	65±8	40-110	74±14	50-190	1.13
Average	113±26	60-202	119±27	65-245	1.06

Absorbed indoors dose (mSv) = (D_{in}× OF× T) =0.83

Absorbed outdoors dose (mSv) = (D_{in}× OF× T) =0.2

The annual effective dose (mSv) = total absorbed dose× the conversion coefficient = (0.83+0.2) × 0.7= 0.72mSv.

DISCUSSION

Studies of background radiation measurements are of great importance in most countries [10, 11, 13]. The results obtained by a GM detector, showed that the average outdoor dose rate in Lorestan province was about 113±26 $nSvh^{-1}$, from 60-202 $nSvh^{-1}$. This value was due to terrestrial radioactive sources and the cosmic rays. The achieved has been higher result in comparison with the values reported by UNSCEAR 2000 from different countries (with the mean of 59 $nGyh^{-1}$ in the range of 18- 93 $nGyh^{-1}$) [4], but it was lower than the values, which are reported from the other cities in Iran such as Zanjan[12] (127 $nSvh^{-1}$), Isfahan (137 $nSvh^{-1}$), Oromeih (154 $nSvh^{-1}$) , Gonabad (120 $nSvh^{-1}$) and Baneh (199 $nSvh^{-1}$); Also it was higher than from values of other cities in Iran such as Mashhad (91$nSvh^{-1}$), Tabriz (114 $nSvh^{-1}$) and Yazd (101 $nSvh^{-1}$)[5-9].

The mean value due to indoor radiation was measured as 119±27 $nSvh^{-1}$ ranges of 60-245 $nSvh^{-1}$. The result was higher than the mean absorbed dose rate that has been reported by UNSCEAR 2000; (with the mean of 84 $nSvh^{-1}$ in the range of 20-200 $nSvh^{-1}$).

The highest values reported for indoors are in Malaysia, China, Hungary, Albania, Portugal, Australia, Italy, Spain, Sweden and Iran, which is probably because of the wide use of stone or masonry materials in buildings [3]. There is a substantial altitude effect [1, 12] for both direct ionizing and photon component, and the neutron component of cosmic rays. Figure 3 shows the correlation between altitude and dose rate for the selected regions in Lorestan. The figure slightly approves the effect of the altitude on the level of background radiation. It means that only 53% of dose rates can be explained to increasing altitude. Some cities such as Doroud, Azna, and Aligoudarz showed high background radiation in spite of their low altitude. This is probably the reason for the poor correlation coefficient between altitude and dose rate. This can be caused by the existence of large quarries (22% of total quarries in Iran) in the eastern areas of the Lorestan province. These quarries may increase the gamma background radiation in these cities. On the other hand, the comparison between the

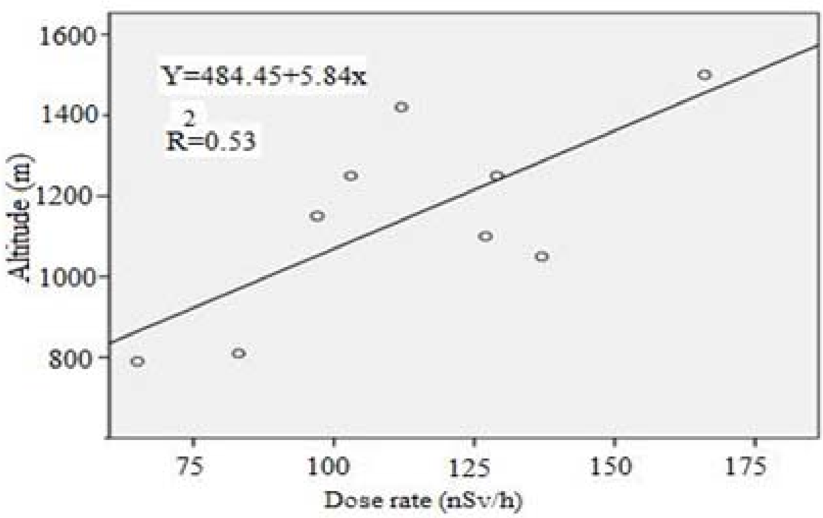

Figure 3. Correlation between the altitude and the dose rate in selected regions in Lorestan province.

highest and lowest altitude regions showed a good correlation coefficient between altitude and exposure rate. For example dose rate was maximum in Borujerd with the highest city (1500m above sea level), and minimum in Pol-e-dokhtar with the lowest altitude (790m) above sea level. Therefore, the higher altitude regions have higher gamma background radiation levels. The indoor effective dose rate was higher than the outdoor dose rate in all cities except in Borujerd. Although the stone or masonry buildings materials in all cities are approximately alike, in Borujerd the ratio of indoor to outdoor was less which is probably because of its higher altitude comparing with other cities.

CONCLUSION

The average annual effective dose for gamma background radiation in Lorestan province was 0.72 mSv, with the range of 0.3– 0.6 mSv which is more than the global value (0.48 mSv). Generally a poor correlation coefficient was observed between altitude and exposure rates.

REFERENCES

1. Erol Kam and Ahmet Bozkurt (2007) Environmental radioactivity measurements in Kastamonu region of northern Turkey. *Applied Radiation and Isotops, **65**:440-444.*
2. Ahmet Bozkurt, Nuri Yorulmaz, Erol Kam and et al (2007) Assessment of environmental radioactivity for Sanliurfa region of southeastern Turkey. *Radiation Measurement, **42**: 1387-1391.*
3. United Nations Scientific Committee on the Effects of Atomic Radiation, Annex B (2000). Exposures from natural radiation sources (New York: USA).
4. Sohrabi M, Bolorchi H, Beitollahi S (1996) Natural radioactivity of soil sample in the high level radiation areas of Iran. Proceeding of the 4th International Conference on High Levels. *Beijing China, 129-132.*
5. Bahrayni MT and Oroji MH (1999) Survey of the environmental gamma radiation in Mashhad city. *J Iran Univ Med Sci, **3**: 117–121.*
6. Bahrayni, MT and Sadeghzadeh A (2000) Evaluation of the environmental gamma radiation in Azerbaijan. *J Iran Univ Med Sci, **3**: 1–7.*
7. Tavakoli MB (2003) Annual background radiation in the City of Isfahan. *Med Sci Monit, **9**: 7–10.*
8. Shahbazi-Gahrouei D (2003) Annual background radiation in Chaharmahal and Bakhtiari province. *Iran J Radiat Res, **1**: 87–91.*
9. Bouzarjomeheri F and Ehrampoush MH (2005) Gamma background radiation in Yazd province, a preliminary report. *Iran J Radiat Res, **3**: 7–20.*
10. Mora P (2003) Outdoor and indoor dose assessment using environmental thermoluminescence dosimeter (TLD_s) in Costa Rica. *J Radiol Prot, **23**:431-437.*
11. Zerquera TJ, Sauchez P, Alonso P (2001) Study on external exposure dose received by the Cuban population from environmental radiation sources. *Radiol Prot Dosimetry, **95**:49-52.*
12. Saghatchi F, Salouti M, Eslami A (2008) Assessment of annual effective dose duo to natural gamma radiation in Zanjan (Iran). *Radiation Protection Dosimetry, **132**: 346 –349*
13. Bahreyni Toossi MT, Bayani SH, Yarahmadi M, Aghamir A, Jomehzadeh A, Hagh Parast M, Tamjidi A (2009) Gonad, bone marrow and effective dose to the population of more than 90 towns and cities of Iran, arising from environmental gamma radiation. *Iran J Radiat Res, **7**: 41-47.*