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Estimation of external natural background gamma ray doses to the population of Caspian coastal provinces in North of Iran

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Background: The effect of natural background radiation on health is still controversial. However, it is clear that it depends on the dose received by the population. The estimation of external natural background gamma rays received by the population of Caspian coastal provinces in the northern part of Iran was the main goal of this study. ***Materials and Methods:*** Gamma rays was measured using calibrated radiation survey meter in 51 urban and rural health centers randomly to estimate the exposure to population (Total population = 6888118 persons) in residential areas of Gilan, Mazandaran and Golestan (Total area 59240 Km^2) as Caspian coastal provinces, North of Iran. ***Results:*** Results showed that the average dose rate in the areas under study was about 60.37±14.88 nSv/h or 0.53 mSv/yr (Range 30 to 90 nSv/h or 0.26 to 0.79 mSv/yr). The data from Ramsar was excluded from the estimation because of its very high natural background radiation (Max. 240 mSv/yr). No significant difference was found among the doses of the provinces (P=0.237). ***Conclusion:*** The external natural background gamma ray dose to the population of Caspian coastal provinces, North of Iran, was found to be almost equal to the average value in the world (0.5 mSv/yr).
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INTRODUCTION

Large populations all over the world continue to be exposed to natural background radiation [(1)]. It should be noted that the biological effects of relatively high doses of radiation have been noticed a little after the discovery of X–ray and radioactivity. However, the effect of the natural background radiation at low and very low doses on human health is still the matter of concern [(2)]. Therefore, the first step for determining health effects of radiation is measuring the exposure dose. The natural background radiation dose/dose rate has been investigated by many researchers in various parts of the world and a wide range of results are reported [(3-6)]. The risk of cancer from natural background radiation is still challenging [(7)]. As the northern parts of Iran are located on the cancer belt and the frequency of cancer in these areas seems to be higher than some other regions, the estimation of external natural background gamma rays doses to the population of Caspian coastal provinces in north of Iran was the main goal of the present study to determine its significance on higher cancer incidence.

MATERIALS AND METHODS

Environmental terrestrial gamma radiation dose rates were measured using a Geiger survey meter (Graetz X5CPlus, Germany) calibrated by Iranian Atomic Energy Organization (IAEO) in random 51 urban and rural health centers to estimate the exposure to population (Total population = 6888118 persons and total area 59240 Km^2) in residential areas of Gilan (Population = 2658902 persons, Area 14711 Km^2), Mazandaran (Population = 2602008 persons, Area 24091 Km^2), and Golestan (Population = 1627208 persons, Area 20438 Km^2) as Caspian coastal provinces in north

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of Iran. The exposure measurement was done by holding the survey meter 100 cm above the ground level for 1 minute as reading time, and each measurement was repeated for three times. It was supposed that all gamma rays were emitted from soil and absorbed by inhabitants. Local health centers were used as dosimetry places because of 98.9% coverage of population for health services. Data were analyzed by ANOVA using SPSS-16 software. Figure 1 depicts the area under investigation.

Figure 1. The total area under study.

RESULTS

Results showed that the average dose rate in the total area under study was about 0.53±0.13 mSv/yr (Range 0.26 to 0.79 mSv/yr). The data from Ramsar was excluded from the estimation because of a very high natural background radiation found in that area (Max. 240 mSv/yr) (8, 9). According to the report of UNSCEAR-2000 (2), the coastal city, Ramsar, involves the highest background radiation among the whole residential areas in the world. The radioactivity of the area was mainly due to Ra-226 and its decay products which have been brought up to earth surface by hot springs, water. There are more than 50 hot springs with different concentrations of radium in the Ramsar which are usually used as spas by the residents and visitors (10). So far, the reported maximum dose has been 13 mSv in Kerala and about 240 mSv in Ramsar per year (9). Table 1, 2 and 3 show the dose rates of different places in Gilan, Golestan and Mazandaran provinces respectively. No significant difference was found among the doses of the mentioned provinces (P=0.237).

Table 1. The external gamma dose rates in urban and rural areas in Gilan Province.

Area	Dose Rate (mSv/yr)
Somesara/Hendkhale/Markaz	0.60
Somesara/Hendkhale/Khane	0.43
Somesara/Laksar	0.39
Somesara/Nargestan	0.48
Somesara/Chamsaghal	0.49
Somesara/Sookhiande	0.63
Amlash/Girgooraber/Markaz	0.53
Amlash/Girgooraber/Khane	0.64
Amlash/Kashkoor	0.68
Shaft/Choobar	0.61
Shaft/Bijarsar	0.57
Shaft/Mobarakabad	0.44
Astara/Sayadlarcheran	0.48
Astara/Gilde	0.50
Astane/Sakookalaye	0.35
Astane/Lashkam	0.76
Astane/Sookhtehkooh	0.79
Mean ± SD	0.55 ± 0.13

Table 2. The external gamma dose rates in urban and rural areas in Golestan Province.

Area	Dose Rate (mSv/yr)
Kordkooy/Alang	0.49
Kordkooy/Chardeh	0.48
Ramian/Sadabad	0.54
Ramian/Arazgol	0.53
Gonbad/Gavaznitape	0.59
Gonbad/Sarli	0.54
Kalaleh/Malaysheykh	0.70
Kalale/Ginglik	0.61
Kalaleh/Soofisheykhdaz	0.66
Mean ± SD	0.57 ± 0.07

Table 3. The external gamma dose rates in urban and rural areas in Mazandaran Province.

Area	Dose Rate (mSv/yr)
Mahmoodabad/Azadmon	0.49
Mahmoodabad/bonde	0.48
Amol/Amol	0.54
Amol/Noori	0.53
Amol/Tajan jar/olia	0.59
Amol/Tajanjar/sofla	0.54
Amol/ Tajanjar/ansari	0.70
Tonkabon/Sharifabad	0.61
Tonkabon/Lashtoo	0.66
Tonkabon/Darvishsara	0.44
Sari/Khoramabad	0.57
Sari/Shahableylam	0.39
Sari/Zavarmahale	0.53
Savadkooh/Zirab	0.53
Savadkooh/Zirabbala	0.46
Savadkooh/Madan	0.44
Galoogah	0.54
Galoogah/Lamrask	0.26
Galoogah/Tirtaj	0.26
Galoogah/Sarajmahale	0.66
Galoogah/Ghalepayan	0.26
Chaloos/Marzanabad	0.60
Chaloos/Toolir	0.26
Chaloos/Pardangoon	0.35
Chaloos/Shahrestan	0.74
Mean ± SD	0.50 ± 0.15

DISCUSSION

Results show that the Mean dose rate in the area under study was 0.53 mSv/yr. The average radiation dose rate in some parts of Nigeria is reported by Ajayi *et al.* [3] as 0.53 mSv/yr which is equal with the results achieved in the present study. Harb *et al.* in Egypt [11] and Lu & Zhang in China [12] have reported the natural background radiation levels about 10 times lower than the similar value in the present study. The terrestrial gamma radiation dose rate in North-West areas and Punjab province of Pakistan (0.34 and 0.28 mSv/y respectively) which were investigated by Rahman *et al.* [13] and Fatima *et al.* [4] have been about one-half of the mean dose rate of the present study. Also El-Taher *et al.* [14] from Egypt, Osmanlioglu *et al.* [5] from Turkey and Oyedele [15] from Namibia have measured the dose rate from environmental radioactivity at about 0.39, 0.06 and 0.07 mSv/yr, respectively which have been much lower than the 0.53 mSv/y, especially in the last two cases. Zunic *et al.* [16] have measured the level of natural radiation exposure to the rural population of Yugoslavia as high as 3.77 mSv/yr which is much higher than the measured values in the present study. Table 4 shows comparison between the

Table 4. Comparison between the results of the present and similar studies.

Researchers	Country	Date of Study	Dose Rate (mSv/y)
Ajayi *et al.*[3]	Nigeria	2008	0.53
Harb *et al.* [11]	Egypt	2008	0.05
Lu & Zhang [12]	China	2008	0.05
Rahman *et al.* [13]	Pakistan (north-west areas)	2008	0.34
Fatima *et al.*[4]	Pakistan (Punjab province)	2008	0.28
El-Taher *et al.* [14]	Egypt	2007	0.37
Osmanlioglu *et al.* [5]	Turkey	2007	0.06
Zunic *et al.* [16]	Yugoslavia	2001	3.58
Oyedele [15]	Namibia	2006	0.07
Monfared (Present Study)	Northern Iran	2010	0.53

results of this study and the similar ones. It seems that the values of terrestrial gamma radiation dose rate vary over different soil types and for different underlying geological characteristics presented in various study areas.

In conclusions the external natural background gamma rays doses to the population of Caspian coastal provinces in North of Iran (except for Ramsar) was found to be almost equal to the average world value (0.5 mSv/yr). Further national studies in other provinces are recommended.

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