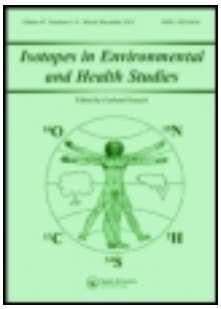

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The highest background radiation school in the world and the health status of its students and their offspring

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The highest background radiation school in the world and the health status of its students and their offspring

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Although the average effective human dose from natural background radiation is about 2.4 mSv per year, the students of the Saeid Nafisi school in Ramsar received effective doses of about 250 mSv while studying there for over 5 years. The goal of this project was a retrospective study of the health status of former students of this school and their offspring. The list of the students of the Saeid Nafisi school (high background radiation) and Taleghani and Kashani schools (ordinary background radiation) was provided by the Department of Education. After matching sex, age and socioeconomic level and obtaining their consent, part 1 of the specifically designed questionnaire was filled out by interview, and clinical examinations were recorded in part 2 of the questionnaire by a physician. The data were analysed using Statistical Package for the Social Sciences 16. Our study shows that 88.1 % of general examinations of high background radiation school students were normal as compared with 85.7 % for control group. There were no significant differences. This study is interesting and unique. It reveals that there is no health emergency related to these high radiation doses. We recommend continuing the health supervision of this population in the future.

Keywords: background radiation; health status; ionogenic radiation exposure; natural radioactivity; Ramsar

1. Introduction

Ramsar (Figure 1) is reputed to have the highest background radiation level among the residential areas in the world [1,2]. The high background radiation level is caused by radon exhalations from hot springs and travertine deposits including radionuclides from the spring water [3]. The maximum and average annual effective doses of Ramsar inhabitants are 260 and 10.2 mSv, respectively [1], while the average effective doses humans receive elsewhere on the planet from natural background radiation is about 2.4 mSv per year [4]. The Saeid Nafisi primary school opened in Ramsar in 1969 and was abandoned in 1994. Without any doubt, this school had the highest background radiation among the schools of the world. The background radiation at the Saeid Nafisi school is 28 μSv/h, and it is estimated that each student of this school, in a 5-year study period, received about 250 mSv from studying at this place. If we consider that most of them lived also in a high

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Figure 1. Ramsar city position on the Iran and the world map.

background radiation area (HBRA) and that they received these doses between ages from 6 to 12 years, the problem is more important.

International rules and standards in radiation protection have been established based on the linear no-threshold (LNT) model. In this model, the carcinogenic risk of radiation increases linearly with the dose within a factor of two [5]. According to the LNT model, it is expected that the students of this school should exhibit some medical problems related to radiation.

The phases of the acute radiation syndrome are prodromal syndrome, latent and critical period. In prodromal syndrome, gastrointestinal and neuromuscular symptoms are seen. The gastrointestinal symptoms are anorexia, nausea, vomiting, diarrhoea, intestinal cramps, salivation, fluid loss, dehydration and weight loss. The neuromuscular symptoms include easy fatigability, apathy or listlessness, sweating, fever, headache and hypotension [6]. Although HBRAs with low dose rate exposures have different health outcomes, the key point about this study is that these people took these chronic doses over a 5-year period.

On the other hand, as recent studies showed, these doses of radiation received chronically over long time spans may have different effects than higher doses received instantly or in a short time span. These studies suggest that for these doses of radiation, the LNT model is not suitable [5].

Eighteen years ago, the Saeid Nafisi school was abandoned because of its high natural background radiation, fell in ruins, and its ground has been unused since then. At this late date, we decided to study the health status of the former students of the Saeid Nafisi school as well their offspring, searching for signs of any harmful effects of radiation.

2. Material and methods

2.1. *Participants*

The students of the Saeid Nafisi school (high background radiation) and the Taleghani and Kashani schools (ordinary background radiation) were studied.

2.2. *Instruments and procedure*

The Saeid Nafisi school had been used for 25 years, and according to the documents in the Ramsar Department of Education (RDE), about 1190 individuals had their primary education in this place.

In this study, the health status of its students and their offspring was studied in a retrospective analysis after at least 18 years (the school was closed in 1994).

We obtained lists of the students of the Saeid Nafisi school (high natural background radiation) and of the Taleghani and Kashani schools (ordinary background radiation) from the RDE. The sample size was determined in consultation with Department of Statistics and Epidemiology. For randomisation, the numbers of 1, 20, 40, 80–1180 were selected from the list. In the case of a problem in obtaining consent or other problems, the next number in the list was selected. The method was approved by the accredited Ethics Committee of Babol University of Medical Sciences, Babol, Iran.

Then by calling on the individuals at their home addresses and after explaining the aim of the project to them and obtaining their consent, the primary questionnaire was completed by interview: studies in their school and other indices about social-economic, job, sex, age, education, income and diet. After excluding confounding factors, an appointment was made with a general physician in the Ramsar Local Health Centre (RLHC) and an ID number was given to each individual. At the medical visit, blinding was achieved by using their ID numbers, and without any information to the former students about receiving extra radiation doses, standard questionnaires were completed through interview and available data in RLHC. Then a general physician visited them and if he recommended, a further examination was performed. The blood pressure, heart rate and sounds, pulse pattern, lung sound and other general examinations were done by the physician for all of the participants. Moreover, the complete blood cell (CBC) count including white cell differentiations, fasting blood sugar (FBS) tests and urine analysis (UA) were done for all the 31 participants whose general examinations were not in normal ranges. After the proposal had been approved by the research committee of the Babol University of Medical Sciences and taking the list from RDE, the examinations were performed over a period of 5 months.

We studied 111 individuals (58 males and 53 females) and their offspring from the Saeid Nafisi school (study group) and 126 (61 males and 65 females) former students and their offspring from Taleghani and Kashani schools (control group).

The study group consisted of 59 former students of high background radiation school (HBRS), 48 offspring and 2 former students whose parents were also students of the school and 2 teachers. One person had died 7 years ago and 110 people were alive and interviewed and examined.

The control group consisted of 59 former students of the ordinary background radiation schools (OBRS), 67 offspring and 2 teachers. Two persons had died and 126 were interviewed and examined.

The average age for the study group was 26.4 ± 15.8 years (for former students and their next generations 37.5 ± 8.0 and 11.3 ± 7.7, respectively). It was 27.6 ± 16.1 years (former students and their offspring 38.4 ± 8.3 and 13.2 ± 7.5, respectively) for the control group.

2.3. *Data analysis*

The data were analysed by the independent t-test for quantitative variables and Chi-square and Fisher's exact test for qualitative variables using Statistical Package for the Social Sciences 16 and $p < 0.05$ assumed significance.

3. Results

The medical examinations and CBC, FBS, UA tests showed that 97 cases of the study group (88.1 %) and 108 cases of the control group (85.7 %) were normal. Other individuals were suffering from anaemia, diabetic, peptic ulcer, sinusitis, constipation, goitre, redness of neck skin

with itching and scaling, high cholesterol, arthritis, joint pain, asthma, nasal polyps, constipation, migraine, psoriasis, arthritis, heart disease and blood pressure problems.

The medical examination results for weight loss, weakness, cramps, frequent headaches, tingling, diplopic, dizziness, tinnitus, epistaxis, swallowing difficulty, loss of appetite, abdominal fullness feeling, gastrointestinal bleeding, bone pain, jaundice, skin discoloration, petechiae and dyspnoea are shown in Figure 2.

The results for heart disease, chest pain, palpitations in recent months, pulse pattern, jugular venous pressure examinations and lung sound examinations, fainting, lymphadenopathy, brain pressure are shown in Figure 3. One of the students in the HBRS study group had died 7 years ago of heart failure. In this study group, one case had crushing pain and four individuals had radiating

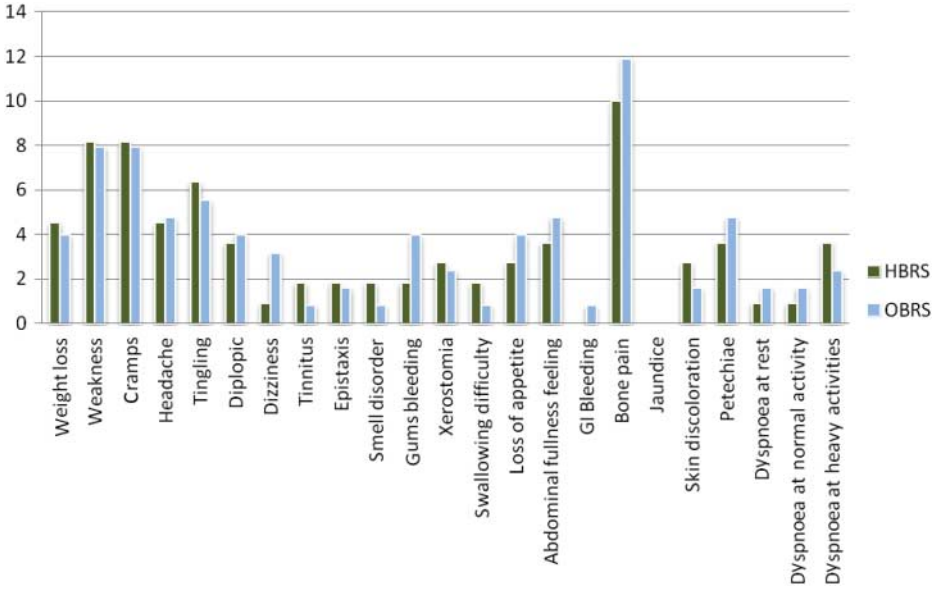

Figure 2. The percentages of disturbations in general wellbeing in study (HBRS) and control (OBRS) groups.

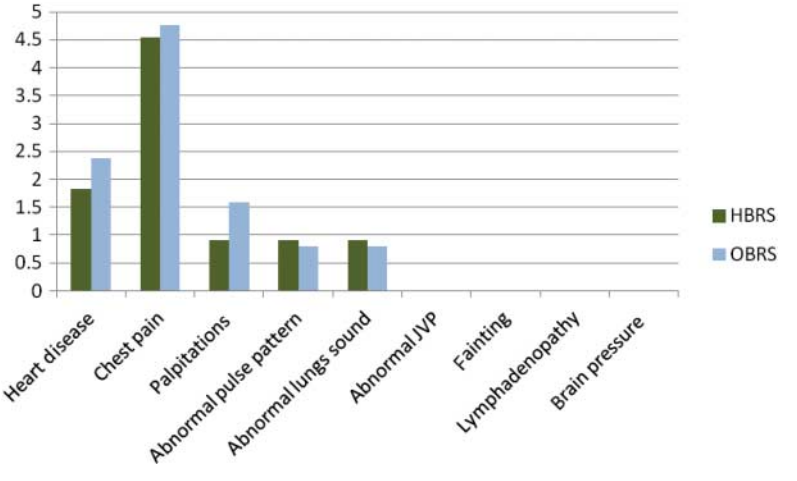

Figure 3. The percentages of organ based abnormal indices in study (HBRS) and control (OBRS) groups.

pain; also, the chest pains of two individuals were not described and in three cases got worse with activity. These numbers were 2, 4, 2, and 4 for the control group, respectively.

The examinations of eye sclera were normal but oral mucosa in 1 case was pale in the HBRS study group. The ophthalmoscopy tests were normal while voluntary and involuntary movement of the eyes was normal in both study and control groups.

For the HBRS study group, there were 12 cases with hospitalisation history including 5 surgeries, 2 heart diseases and 5 for other purposes, and there were 13 cases of cancer, 6 sudden deaths, 6 infertilities and 1 congenital anomaly between the relatives of these 110 individuals. For this group, there were 3 abortion histories among the 53 studied females and among the 58 males, the wives of 2 had had abortions.

For the OBRS control group there were 14 cases with hospitalisation history including 8 surgeries, 3 heart diseases and 3 for other purposes, and there were 15 cases of cancer, 5 sudden deaths, and 4 infertilities among the relatives of these 126 individuals. For this group, there were 3 abortion histories among the 61 studied females.

4. Discussions

Former students of the Saeid Nafisi primary school, which closed 18 years ago, had indubitably the highest background radiation among the schools in the world, and their offspring were compared with a matched control group in this study. Each student of HBRS received at least 200 mSv effective radiation dose over 5 years as a student in this school.

In the study group 88.1 % had normal examinations results. All interviewers younger than 20 years were fully healthy. In the control group 85.7 % were normal.

Exposure over years at elevated radiation levels could cause what has been called ‘chronic radiation disease’. Because years have passed since the children last attended the Saeid Nafisi school, acute radiation effects would not be expected.

The 2006 study of health indices in 402 residents of HBRAs and their comparison with 374 inhabitants of adjacent normal areas showed that the two groups were not significantly different, and in fact for some indices the HBRA inhabitants were better [7], although in that study the range of received effective doses and the ages of participants was wider. Moreover, the Saeid Nafisi school environment is one of higher background radiation in Ramsar, so in our study, the participants received at least three times higher effective doses of radiation. The other important point is that these people received these doses in their childhood when radiosensitivity is higher than with adults.

In the 2008 study on the health status of residents living near the Semipalatinsk nuclear test site, the authors reported that radiation exposure has influenced the incidence of some specific medical conditions [8].

The health status of children up to 14 years living in an area of long-term post-accident exposure to low doses of ionising radiation was studied earlier by Ponomarenko [9]. The author reported a high level of abnormalities in the physical development of the children examined and an excess morbidity of both general and separate classes of disease entities among the paediatric population having been victims of the Chernobyl accident, as compared to that in relatively ‘clean’ areas and in Ukraine as a whole [9].

The study of the health status of children living in radiation-polluted regions, 9–11 months after the Chernobyl accident, showed that demographic characteristics, distribution into health groups and the hematological parameters did not reveal any significant differences with the exception of a higher anaemia incidence (in children under 1 year) [10].

5. Conclusion

This study is unique because the Saeid Nafisi school at Ramsar is certainly the most radioactive school in the world. It has been attended during 25 years by a full generation of young students from ages 6 to 12. At no other time in human history and certainly nowhere else on the planet to our knowledge, has a similar group of young children ever attended primary school with such high natural background radiation.

All of the subjects of this study less than 20 years of age were fully healthy and 88.1 % of the study group were normal (more than the control but with no significant difference). The age range was from 9 months to 74 years.

No evidence of any significant negative health effects known to be related to radiation exposure was observed, neither in the former students nor their offspring.

Nevertheless, we recommend that more supervisory action by the local health centre should be continued over the years in the future, in following the former students' health and that of their offspring. It seems that there is no need for immediate action by health policy-makers.

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References

[1] UNSCEAR. Sources and effects of ionizing radiation. New York: United Nations Science Committee on the Effects of Atomic Radiation; 2000.
[2] Borzoueisileh S, Shabestani Monfared A, Abediankenari S, Mostafazadeh A, Khosravifarsani M, Amiri M, Elahi-manesh F. The comparison of CD4/CD8 ratio among high and ordinary background radiation areas in Ramsar. Iran Int J Low Radiat. 2011;8:329–337.
[3] Beitollahi MM, Ghiassi-Nejad M, Esmaeli A, Dunker R. Radiological studies in the hot spring region of Mahallat. Central Iran Radiat Prot Dosim. 2007;123:505–508.
[4] Tao Z, Zha Y, Akiba S, Sun Q, Zou J, Li J, Liu Y, Kato H, Sugahara T, Wei L. Cancer mortality in the high background radiation areas of Yangjiang, China during the period between 1979 and 1995. J Radiat Res. 2000;41:31–41.
[5] Averbeck D. Does scientific evidence support a change from the LNT model for low-dose radiation risk extrapolation? Health Phys. 2009;97:493–504.
[6] Hall EJ, Giaccia AJ. Radiobiology for the radiologist. 6th ed. Philadelphia (PA): Lippincott Williams & Wilkins; 2006. Acute effects of total-body irradiation; p. 118–128.
[7] Shabestani Monfared A, Jalali F, Sedaghat S, Mansoorizade E, Jarrahi A, Hajiahmadi M, Samavat H. High natural background radiation areas in Ramsar, Iran: can inhabitants feel safe? Int J Low Radiat. 2006;3:171–177.
[8] Hirabayashi K, Kawano N, Ohtaki M, Harada Y, Harada H, Muldagaliyev T, Apsalikov K, Hoshi M. Health status of radiation exposed residents living near the Semipalatinsk Nuclear Test Site based on health assessment by interview. Hiroshima J Med Sci. 2008;57:27–35.
[9] Ponomarenko VM. The health status of children up to 14 years old living in an area of long-term post-accident exposure to low doses of ionizing radiation. Lik Sprava. 1995;(5–6):12–15. Russian.
[10] Koshel IV, Rumiantsev AG. Health status of children exposed to low doses of radiation 1 year after the Chernobyl AES accident. Pediatriia. 1991;(12):13–16. Russian.