The objectives of the SEMIPALATINSK project were 1) To establish a bank of blood samples of three generations of families living close to the Semipalatinsk nuclear test site and control families from clean areas, 2) To reconstruct radiation doses by using biomarkers of radiation exposure, and 3) To determine the germline minisatellite mutation rates of exposed people and the control families of the same ethnic origin living in non-contaminated areas.

The overall objective was to provide information relevant to the genetic risk assessment of exposure to ionising radiation in chronically exposed human populations and to provide advice for local authorities in order to help them mitigate the effects of ionising radiation on the population around the Semipalatinsk nuclear test site.

Challenges to be met

Information on the exposure of the local population has been available to the international scientific community only since the 1990’s. Many of the people that received the highest doses after the surface tests performed in 1949-1956 are now old and soon no longer available for examinations. To learn more on radiation effects in the future using technologies not yet available, biological samples need to be stored.

Reconstruction of radiation doses is an essential step in order to obtain quantitative information on the health risk of radiation. The participants in the project have used biomarkers of radiation exposure to assess the exposure of people that have been living in the most contaminated villages since the first Soviet nuclear test in August 1949. Stable chromosomal translocations in blood lymphocytes were analysed for dose reconstruction. In addition, glycophorin A (GPA) mutations in erythrocytes were analysed by a US laboratory (University of Pittsburgh).

Genetic risk estimates for man from exposure to ionising radiation have been based mainly on the information from animal experiments and general knowledge of radiation biology. No significant elevation of heritable mutation rate has been observed in the children of A-bomb survivors in Hiroshima and Nagasaki (Japan) by using standard genetic methods. Tandem repeat minisatellite loci monitoring of germline mutation in man is a new and sensitive approach.

Achievements

A biological sample database with an accompanying registry of background information on the examined subjects has been established for long-term storage of frozen lymphocytes, blood cell DNA and EDTA blood. Biosamples from 361 individuals living near the Semipalatinsk test site and 251 controls from Taldy Kurgan area are available for future studies addressing genetic effects of ionising radiation.

Chromosomal translocation frequencies in the Semipalatinsk and the control groups were similar. This suggests that on average, the magnitude of exposure to the examined group in the Semipalatinsk area has been considerably smaller than that reported in the local registries. Previously reported doses of the order of 1-4.5 Gy (2.9 Gy on average among the grandparent generation that lived in the villages at the time of testing) cannot be confirmed by the
present data. A more likely dose estimate is below 0.5 Gy. A similar conclusion was drawn on the basis of the GPA mutation data.

Differences in hereditary minisatellite mutation rates between the two rural populations from the Semipalatinsk and Taldy Kurgan Districts of Kazakhstan were small in general. However, the minisatellite mutation rate in the P0 generation (grandparents) directly exposed to radioactive fallout from the surface and atmospheric nuclear tests was 1.7-fold higher than in the control non-exposed population from the Taldy Kurgan District. Moreover, the minisatellite mutation rate in the F1 generation (parents) from the affected area showed a significant negative correlation with the year of birth. The mutation rate among those that were born in the 1950’s (during atmospheric testing) was significantly elevated, whereas no increase in the germline minisatellite mutation rate was observed amongst those that were born in the 60’s and 70’s and thus were exposed to considerably smaller radiation doses.

**Partnership**

The project brought together five competent Kazakh, European and US laboratories having knowledge on radiation dose reconstruction, genetic effects of ionising radiation, epidemiology, molecular biology and radiation protection. Three Kazakh post doctoral scientists were trained in European laboratories on molecular cytogenetic and mutation analysis techniques.

**Selected references**
