Introduction

The estimation of the current status and the prediction of delayed health effects following the exposure of the population of Russia and the Republic of Belarus to radionuclides emitted in the Chernobyl accident is of great social and economical value because millions of people were subjected to some radiation in these countries.

By 1997 the number of years passed after the Chernobyl accident had exceeded the latent period for induction of radiation-associated cancer. This can cause and has already caused increase in cancer morbidity modified by any radiation exposure. Thyroid cancer is particularly interesting because radiation-related thyroid cancer, similar to leukemia, has a short latent period of five years since the exposure.

The principal group under risk for an excess (over baseline) of radiation-induced thyroid cancer, are liquidators who got high radiation doses, and the population residing in territories contaminated with radionuclides, particularly those individuals who were children and adolescents at the time of the accident for two reasons. The risk for induction of radiation-associated thyroid cancer was expected to increase greatly with decrease of the age under exposure, and the thyroid dose from incorporated iodine depends on the age, being highest in children and adolescents. The studies recently performed confirm these suggestions. Statistically reliable data show the relationship between radiation exposure and increase in thyroid cancer incidence among those who were children and adolescents at the time of exposure. A statistically plausible increase, over the baseline, in thyroid cancer incidence among liquidators has been noted as well.

To estimate the expected health effects of the exposure of the thyroid to radioactive iodine, information on the radiation risks of induction of the disease, as well as the relationship between the risk and sex and age under exposure, age at diagnosis should be available.

The main source of information, which is used for acquiring new knowledge of the role of radiation risks and the shape of dose-effect curve, is the cohort of A-bomb survivors in Japan. However, the parameters of irradiation, social and economical conditions, ethnic and geographical features of the Japanese cohort differs considerably from Russian and Belarussian conditions. We believe, therefore, that it would be improper to apply the results of the studies of that cohort to the analysis of health status of, and prediction of, delayed effects of the exposure to radiation following the Chernobyl accident. It is necessary to estimate the radiation risks for thyroid cancer on the basis of medical and dosimetric information, which has been accumulated in the states of the former USSR for the years since after the accident.

As is well known, most of Russia's data on health effects of the Chernobyl accident has been stored in the database of the Russian National Medical and Dosimetric Registry (RNMDR) which is located in the town of Obninsk.

Unfortunately, it is very difficult to assess accurately radiation risks after the Chernobyl accident with Russian data only (particularly for such a rare disease as thyroid cancer), because there is a short period of follow-up and there is a small number of cases under analysis. There is a similar situation is in the Republic of Belarus. It is more reasonable to establish a common bank of medical and dosimetric data of the national registries of the two states and to carry out joint radiation epidemiological studies.

A database of all cancer cases detected in the Republic of Belarus, including all personal data, is sent to, kept, and analyzed at, the Belarus Center for Modern Medical Technologies (BelCMMT).

Due to the practical implementation of the Program on the joint activities towards overcoming consequences of the Chernobyl accident within frames of the Belarussian-Russian Union for 1998-2000 in the health care system, there is a real possibility to make a prediction of the health status of people subjected to additional exposure to radiation. The basic outcome of radiation epidemiological research work to be implemented within the framework of the program is new knowledge about the magnitude of radiation risks and the shapes of dose-response curves, as well as identification of the basic trends in the incidence and mortality among exposed people residing in Russia and Belarus. The results to be obtained will serve as theoretical support for actions of health care institutions of both states aimed at minimization of health effects of the Chernobyl accident. The expected results will be valuable for the development of the strategy for nuclear industry and nuclear technologies, not only in Russia and Belarus but in the rest of the world.

This special issue of this Bulletin "Radiation and Risk" (1999) contains the first results of the study performed within the framework of the Belarus-Russian Program on their joint activities towards the minimization of the consequences of the Chernobyl accident. One outcome of the study is the establishment of the Joint Registry of Russia and Belarus on thyroid cancer. It consists of all thyroid cancer cases detected in the four mostly contaminated oblasts of Russia (Bryansk, Kaluga, Oriol, Tula) and the whole territory of the Republic of Belarus from 1982 to 1997.

Note by Editor of the English version:

It is hard to overestimate the importance of this work. Not only does it provide for the world the best information we have on the risk of thyroid cancer following radiation (from ingestion of radioactive iodine), but it also marks a cooperation between Russian and Belarussian scientists that we feared had been lost in 1991 when the Soviet Union broke up.

1. TECHNOLOGY FOR COLLECTION AND ANALYSIS OF PERSONIFIED DATA OF THE JOINT REGISTRY OF RUSSIA AND BELARUS ON THYROID CANCER

To introduce a common technology for the collection and analysis of data, including personal data, necessary for setting up of the Joint Registry of Russia and Belarus on thyroid cancer among people exposed to radiation as a result of the Chernobyl accident, an analysis of the existing organizational and technical systems for registration of cancer diseases had to be done.

At the present time in Russia the statistical data for malignant neoplasms is the basis for the estimation of cancer morbidity and for the development of anticancer preventive measures. The main feature of the Russian national sanitary statistics is its systemic organization and close relation to practical health care. Temporal variations of cancer morbidity are taken into account by all levels of practical health care institutions at the planning of the complex of anticancer measures. The outcome of their activities completely meets the needs of the strategic national planning in the health care system, however for solving local tasks data of the national statistics must be more accurate.

Despite the fact that the system for registration of cancer morbidity and mortality is a permanently operating system which is already used for planning and management, reporting is not quite perfect in Russia, so that the system does not fully meet the current requirements for a system of cancer relief.

The accident at the Chernobyl NPP and the concomitant problem of the estimation of the adverse effects on the health status of the population exposured to radiation, highlighted in Russia the necessity for using the system for advanced surveillance of cancer morbidity and mortality. This should be based on the centralized registration of cancer cases with state-of-the-art computer technologies. So, a common personified cancer registry had to be set up in the Russian Federation, and first it had to be organized in the territories contaminated with radionuclides.

It should be noted that in the last two to three years practical work on setting up the system for the National cancer registry was started in the Russian Federation. The order of the Ministry of Health of Russia, N 420 dated of 23.12.96, “On setting up National cancer registry“ was released. Primary documents and software have been developed. The current system organizational structure, however, cannot be introduced into practice. More effective procedures for collection and storage of information, including personal information, on cancer patients must be found for analysis of the oncoepidemiological situation in territories contaminated with radionuclides in Russia by Chernobyl.

In the territory of Russia oblast (kraj, republican) oncological dispensaries analyze and examine the primary registration data and the reporting documents for further estimation of the state of anticancer service in their territories. Oncological statistics of oncodispensaries study cancer prevalence among the whole population and the specific groups; the relative incidence of tumors of specific types and sites; geographical, sex-age, occupational and other features of cancer morbidity; effectiveness of anticancer measures.

Existing primary documents of cancer statistics allow one to set up an operatively functioning registry of patients with thyroid cancer that is based on the oncological dispensaries of the four mostly contaminated oblasts of Russia. At the first stage of the work the research studies aimed at the development of a common technology for collection, transferring and analysis of information on thyroid malignant neoplasms in the territories exposed to the Chernobyl accident should be the basis for the estimation of the contribution of the radiation risk factor to temporal variations of cancer morbidity among specific groups of the population.

The approach to the development of a personified thyroid cancer registry can be introduced primarily due to the activities of the RNMDR operating in the Medical Radiological Research Center of Russian Academy of Medical Sciences (MRRC of RAMS). They set up a joint system of measures for medical and dosimetric monitoring of the population residing in the contaminated territories. One of the tasks of an earlier concern, is setting up a cancer sub-registry and thyroid cancer sub-registry which covers four mostly contaminated oblasts of the Russian Federation (Bryansk, Kaluga, Oriol and Tula). This was solved by the RNMDR for the last five years. Personal information on all thyroid cancer cases detected in the territories of interest is sent to the national level of the RNMDR by the system of oblast regional centers and oncological dispensaries of the four oblasts. Once the huge task of the collection of retrospective information was done, data was available on 3496 thyroid cancer cases detected from 1981 to 1998 in the territories of the four oblasts (data on 1998 have been coming).

Below we describe in detail the system for cancer registration in territories of the Republic of Belarus. Cancer cases have been registered there from the 1950s following the order of the Ministry of Health of the former USSR. However, the information collected was quite incomplete until the late 1960s. The first complete statistical data were obtained in the late 1960s.

In 1973 a central computerized cancer registry was put into operation in Belarus. The information basis was called “Dispensary follow-up history”. The histories were completed and coded in all of the 12 dispensaries located in each oblast (region) centers and in some of the cities of the Belarussian Soviet Socialist Republic (BSSR). Once a year the histories were sent to Minsk for centralized treatment. Information from hard copies were transferred to a computer and then carefully examined. Inaccurate information was corrected and input into the computer once again. After correction of the data, files related to a reporting year were recorded on the magnetic disks and tapes. Annual information for each oblast, including City of Minsk, from 1978 is kept in separate files. A file consists of information on all cancer cases detected in previous years that have been registered at a dispensary in the beginning of a current year, as well as information on new cancer cases registered in a reporting year.

Before 1985 information stored on the computer did not include such personal data as a last name, first name, patronymic name, or permanent address. This made verification and correction of data more difficult and led to double counting the information. The quality and reliability of information was improved when an automated system for checking of dispensary follow-up of cancer patients was put into operation in 1985. The treatment of data by means of the system of “Check of monitoring” allowed one to solve the tasks of the long-term accumulation of personal information on cancer patients, the automated check of dispensary examination and computerizing a number of routine operations for control of appointed visits of patients for dispensary examination, preparation and printing calls, inquiries on the health status of patients to out-patient clinics, etc. At the same time technological approaches to statistical treatment of data remained the same. As mentioned above, data from 12 oncological dispensaries responsible for the collection of information on all cancer patients residing in a territory under follow-up are sent to the Belarus cancer-registry.

The majority of cancer patients in Belarus are examined and treated in oncological dispensaries and the Research Institute of Oncology and Medical Radiology in Minsk. This considerably facilitates collection of information of satisfactory quality. Therefore, most of the information taken from primary medical documents (card of an ambulant patient, case history) is entered directly into a personal computer in an oncological dispensary. In addition to that, extracts of medical documents and special notifications from other health care institutions (Research Institute of Oncology, Center for Thyroid Disorders, hematological clinics, clinics that have oncological units, etc.), which diagnosed cancer and provided proper treatment, were also sent to the registry.

An additional source of information for cancer cases are the death certificates. Every month staff members of oncological dispensaries and oncological offices examine ZAGS offices for the certificates with “cancer” listed as the cause of death. All documents are compared with the information in the database from each oncological dispensary. If the information is not available at the database staff members of an oncological dispensary verify data at the source of information, for instance, institution and medical doctor established cause of death. After verification and confirmation, information on new a cancer case is input into the database.

After merging databases of the oblast dispensaries to one database of the Republic of Belarus, computations of temporal variations of cancer incidence rates and cancer incidence ratio can be carried out much more accurately than was possible made with the summarized reports which were used in the Russian system of the specialized cancer service. The database, including personal data, on all cancer cases detected in the Republic of Belarus is located and analyzed at the Belarus Center for Modern Medical Technologies. Information on the health status of the population of Belarus exposed to radiation as a result of the Chernobyl accident (National Registry of the Republic of Belarus) is sent there. The Belarus registry personified information on all cancer patients, as well as on all people exposed to the Chernobyl accident.

Within the framework of the current study, specialists of the Belarus registry provided the Joint Registry of Russia and Belarus with information of satisfactory quality on all thyroid cancer cases detected in the Republic of Belarus.It should be noted that Belarus partners carried out a huge task on verification of retrospective information and delivery to the Joint Registry data on 5409 thyroid cancer cases detected in the Republic of Belarus from 1982 to 1997.

For the development of a common technology for collection of personified data on experienced thyroid cancer in four contaminated oblasts of Russia and in the Republic of Belarus as a whole, workshops and consultations of specialists of national registries were held. It was decided to use unified primary documents, “Control card of dispensary follow-up (onco)” (form N 030-6/U), “Extract from case history of a patient with malignant neoplasm” (form N 027-1/U), “Information on a patient with first in the life detected cancer or another malignant neoplasm” (form N 090/U) as basic information documents. The documents are used in the territory of Russia, as well in the Republic of Belarus. Format of the database for the exchange of information between the two registries was formed on the basis of the above documents. It was done easily because most of the necessary personified information of both parties had been digitized (naturally the parties used different formats for storage). This allows a common format and the exchange of information by means of it. Every thyroid cancer case was given a unique registration number (ID-NUMBER). Bases of depersonalized data with registration numbers instead of last, first and patronymic names were sent to Russia and Belarus.

In addition to information, including personal data, on thyroid cancer, the Joint Registry of Russia and Belarus is supplemented with demographical, medical, statistical, and radioecological data banks, which were formed with the use of information of the two states. Regretfully, it is quite difficult to access the integrated information necessary for the development of supplemented data banks at a rayon and a settlement level, as well as sex and age features broken down into 5-10 year age intervals. It is expensive to obtain information. Supplemental demography data banks and medical oncology statistical data were formed on the basis of official medical and demographical information with the use of available sources of information beginning from published reference books of information bought at committees of statistics at each oblast. It is known that statistical data broken down by sex and age on spontaneous migration of the population at a rayon level do not exist. Nevertheless, at the present time complete demographic information at the oblast level and some data with regard to the top the level of rayon (contaminated territories of Russia) and a settlement (Bryansk oblast, Russia) is in the demographic database. The formation of a demographic database is in progress.

The following actions are being planned towards the formation of a Joint Registry of Russia and Belarus on thyroid cancer cases among people exposed to radiation as a result of the Chernobyl accident:

- to develop the system as a complex of measures including step-by-step collection, checking, verification and archiving of personal information on all thyroid cancer cases in territories of Bryansk, Kaluga, Tula and Oriol oblasts of Russia and in the whole Republic of Belarus;
- to develop the infrastructure of the Joint registry at the expense of establishing the rayon level based at the central rayon hospitals;
- to establish a subsystem of the Joint registry for assessment of risk for development of cancer of different sites as a result of exposure to radiation and non-radiation factors;
- to develop an information and analytical system of the Joint registry which will allow health care bodies of territories of Russia and Belarus covered by the project to make optimal administrative decisions;
- to collect information and to create a bank of data on iodine deficiency, the radiation level and other environmental factors in territories of Russia and Belarus covered by the study;

- to form a bank of personalized data on external and internal radiation doses received by the population included in the Joint registry.

The current study allowed us to introduce a common technology for collection and analysis of personalized information by National registries of two states (RNMDR, MRRC RAMS for Russia and the National registry of BelCMMT for Belarus). The task was aimed at the establishment of a Joint registry of Russia and Belarus on thyroid cancer among people exposed to radiation as a result of the Chernobyl accident. The study allowed us to specify the volume and the quality of the collected information. Items concerning co-operation between specialists of the states, as well as trends for further development of the Joint registry were solved.

2. PRELIMINARY EPIDEMIOLOGICAL ANALYSIS OF DATA OF JOINT REGISTRY OF RUSSIA AND BELARUS ON THYROID CANCER

At the present time data on 8905 thyroid cancer cases among people exposed to radiation following the Chernobyl accident been diagnosed from 1981 through 1998 are in the data bank of the Joint registry of Russia and Belarus. The Russian data bank has been formed on the basis of personal information of oblast cancer dispensaries of Bryansk, Kaluga, Oriol and Tula oblasts which are the most contaminated areas of the Russian Federation, Russian share is 39% (3496 cases) of the total number of the registered. The share of Belarus is 61% (5409 cases) respectively. It must be noted that data for 1981 are available in Russia only, information collected in 1998 are being collected. In what follows analysis will be made only on data from 1982 to 1997.

In Table1 information is given on the absolute number of newly detected thyroid cancer cases in ten oblasts of Russia and Belarus. For the period of follow-up, the largest number of cases have been detected in the Minsk oblast, Belarus. However, the size of population of the oblast is the largest of all. From 1986 to 1989 the largest number of cases were detected in the Bryansk oblast, Russia. From 1990 Gomel, Bryansk and Tula oblasts followed by the Minsk oblast. From 1996 the Oriol oblast was among “leaders”. Table 1 shows the following: after 1986 the number of detected thyroid cancer cases increased tremendously, however, it had been the same for the next three years, about 350-370 cases per year. A considerable increase in the number of detected thyroid cancers had been registered since 1990, in 1997 it was 1100, 4.5 times higher than the annual number before the accident.

In Table 2 the total number of detected thyroid cancer cases is listed for the above period (1982-1997), distributed in accordance with the age at diagnosis. It is seen that there is a similar tendency for an increase in the number of cases in each calendar year, especially after 1990. The largest number was detected among those who were 40-49 years old at diagnosis. The most dramatic increase was observed before and after the accident (especially after 1992) in the group of teenagers (10-14 years old), it was more than 50 times higher compared with the pre-accident level (1982-1986).

In Table 3 the gender distribution of thyroid cancer cases is given, as well as the female/male ratio of detected cases. No obvious changes in the ratio were found. The average female/male ratio is 4.5. The frequency of thyroid cancer cases among women is 4.5 times higher than it is among men.

Table 1. The distribution of thyroid cancer cases by oblasts of Belarus and Russia for the period from 1982 to 1997

Oblasts	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
TOTAL	234	223	209	252	273	369	364	352	422	527	636	879	915	1007	1027	1100
BREST	15	4	13	18	18	16	23	15	26	32	29	87	76	89	105	108
VITEBSK	30	19	22	16	21	28	33	37	47	44	53	64	54	63	77	106
GOMEL	30	14	25	28	28	53	41	43	60	96	94	148	136	143	152	159
GRODNO	5	12	12	15	18	27	12	22	22	35	43	42	72	42	44	29
MINSK	43	66	48	50	45	54	75	49	77	100	141	160	188	196	182	224
MOGILIOV	13	19	17	21	20	25	20	25	30	28	26	55	74	85	86	77
BRYANSK	38	23	20	21	48	75	67	77	58	77	91	112	113	129	101	133
KALUGA	17	14	9	14	9	14	17	20	13	14	20	34	32	21	29	36
ORIOL	22	20	17	22	27	33	39	36	28	42	52	69	62	98	128	115
TULA	21	32	26	47	39	44	37	28	61	59	87	108	108	141	123	113

Table 2. The distribution of thyroid cancer cases by age at diagnosis for the period from 1982 to 1997 (Registry as a whole)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0 - 4	0	0	0	0	0	2	0	1	3	0	0	1	0	0	1	0
5 - 9	0	0	1	0	0	0	2	1	16	34	21	29	25	4	1	1
10 - 14	1	0	0	4	2	4	2	4	11	18	25	54	58	90	73	73
15 - 19	1	2	0	6	3	8	5	2	6	18	15	34	37	38	39	40
20 - 24	7	7	4	3	8	4	7	14	9	16	21	23	38	30	33	32
25 - 29	21	16	12	19	18	23	23	14	16	25	22	31	46	44	44	47
30 - 34	14	19	16	21	29	23	22	32	28	51	42	65	62	75	45	54
35 - 39	11	14	14	23	23	33	34	29	32	47	71	93	77	109	84	99
40 - 44	24	18	12	15	15	28	35	32	47	56	75	107	95	106	123	127
45 - 49	16	25	23	30	30	30	22	20	32	25	57	65	89	122	145	138
50 - 54	40	24	21	26	30	49	42	36	50	50	59	64	81	63	75	94
55 - 59	27	22	29	23	25	48	49	40	44	55	55	88	97	96	117	114
60 - 64	16	22	25	29	30	48	44	49	48	43	67	69	65	76	85	108
65 - 69	16	19	18	18	12	22	32	31	35	36	42	80	61	73	82	87
70 - 74	21	18	12	13	25	22	13	20	18	17	31	40	39	44	50	54
75 - 79	10	9	9	11	9	13	19	18	15	21	16	19	26	17	16	17
80 - 84	3	6	10	9	14	9	11	5	8	12	10	13	14	13	10	8
85+	6	2	3	2	0	3	2	4	4	3	7	4	5	7	4	7

Table 3. The distribution of thyroid cancer cases by gender for the period from 1982 to 1997 (Registry as a whole)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Female	185	192	174	205	216	309	298	294	325	422	505	744	754	818	855	907
Male	49	31	35	47	57	60	66	58	97	105	131	135	161	189	172	193
F/M	3.8	6.2	5.0	4.4	3.8	5.2	4.5	5.1	3.4	4.0	3.9	5.5	4.7	4.3	5.0	4.7

Figures 1 and 2 show the temporal variations of the Standard Incidence Ratio (SIR) (per 1 million people) for thyroid cancer in oblasts of the Republic of Belarus and in four oblasts of Russia that were most contaminated with radionuclides. Figure 1 shows that since 1986 the Gomel oblast has been the first (the highest SIR) among other oblasts of Belarus. Its “leadership” has been more pronounced since 1991. At the same time the Mogiliov oblast, which is second by level of contamination and the dose to the population had one of the latest ranks. Since 1993, however, its rank became higher. From 1993 the Brest oblast has had second or third rank though it is not among the most contaminated areas of Belarus. In figure 2 the temporal variations of the SIR (per 1 million people) for thyroid cancer in the oblasts of Russia are given. Bryansk oblast was seen to have the highest rank from 1986 to 1994, however for the three latest years (1995-1997) the Oriol oblast was the first among other Russian regions, in 1996 the rate of 140 per 1 million people, the highest for the whole period of follow-up both in Russian and Belarussian oblasts being registered there. The highest rate for the Gomel oblast (1997) was 94 per 1 million people.

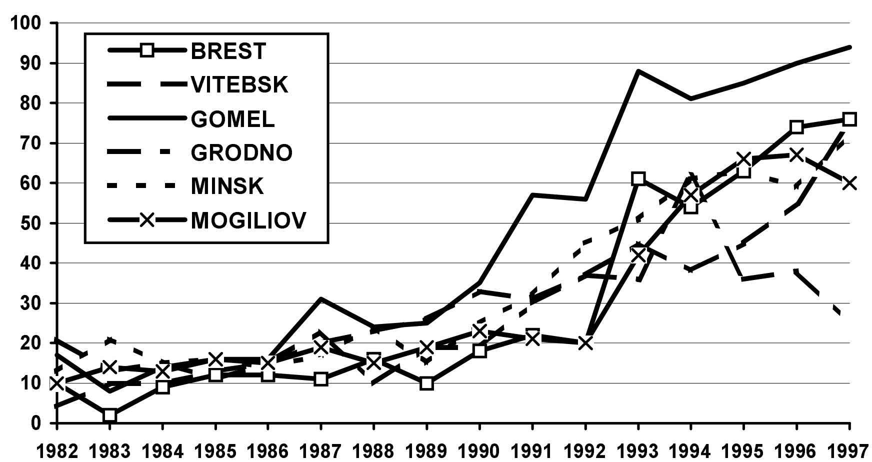


Fig. 1. Temporal variations of the thyroid cancer incidence rate per 1 million residents of Belarus.

Figure 3 shows the temporal variations of thyroid cancer incidence rate in four oblasts of Russia (indication “Russia”) in total, in Belarus as a whole and in the Joint registry as a whole (4 oblasts of Russia and 6 oblasts of Belarus). The similarity of behavior of the rates in Russia and Belarus is quite close, though Russian rates were slightly higher than Belarussian for the whole period of follow-up, except 1984 and 1994. It is possible to see the growth of the incidence rate in Belarus was observed one year earlier (1990) than in Russia (1991). By 1997 the mean rate in the Registry was 72, and the rates in Russia and Belarus were 75 and 70 per 1 million people respectively.

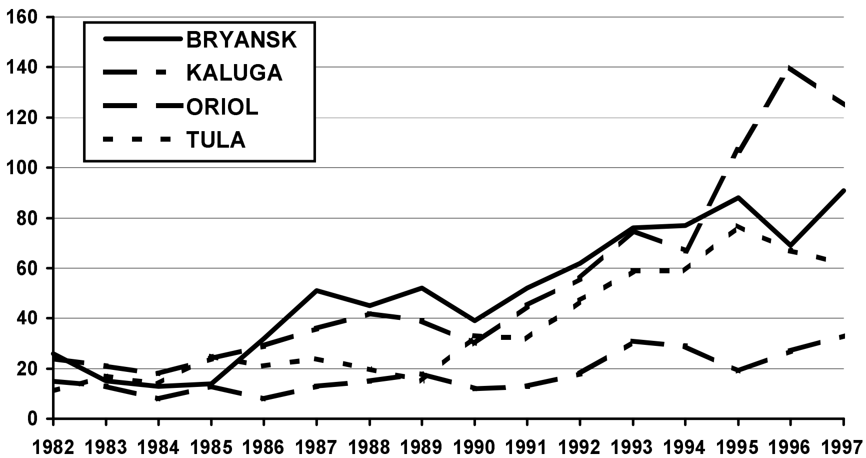


Fig. 2. The temporal variations of the thyroid cancer incidence rate (per 1 million people) in 4 mostly contaminated oblasts of Russia.

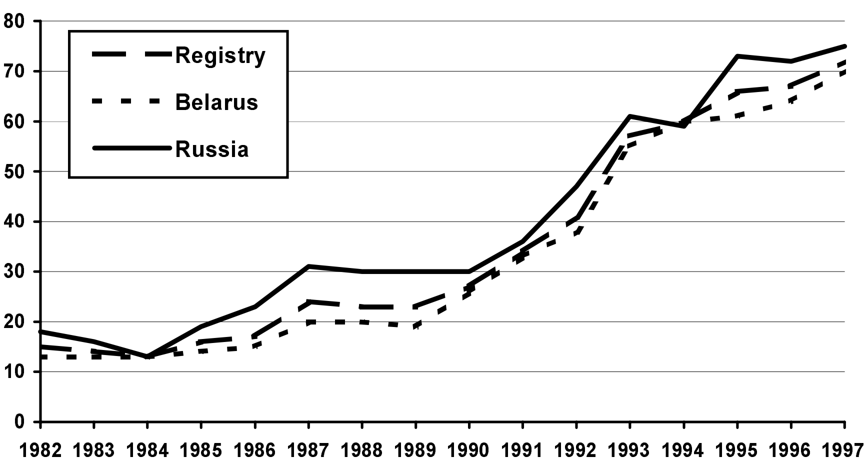


Fig. 3. The temporal variations of the thyroid cancer incidence rate (per 1 million people) in the Registry.

Figures 4 and 5 show the temporal variations of incidence rate among males and females in five “leading” oblasts of Russia and Belarus, “leadership” of the Gomel oblast is evident for males since 1989. The picture in four other oblasts was similar: the growth rate had been observed since 1990-1992. The temporal variations among females were similar to the observed among males, however, there was not true “leader” among the oblasts between 1991 and 1994. From 1995 through 1997 the Oriol oblast had the first rank (the peak was registered in 1996, it was 231 per 1 million people).

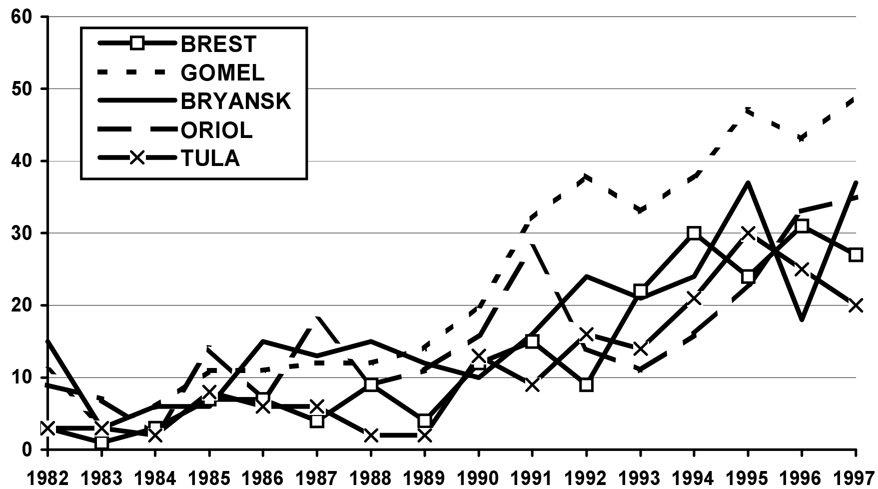


Fig. 4. The temporal variations of the thyroid cancer incidence rate among (per 1 million people) in five oblasts of Russia and Belarus. Males.

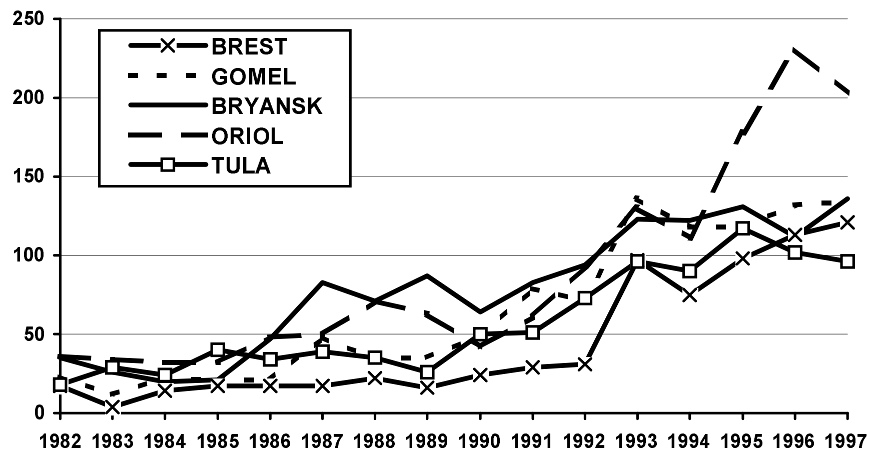


Fig. 5. The temporal variations of the thyroid cancer incidence rate among (per 1 million people) in five oblasts of Russia and Belarus. Females.

The mean annual accumulated age-related thyroid cancer incidence rates in Belarus and four contaminated oblasts of Russia and in the Registry as a whole from 1982 through 1997 are given in figures 6-8 respectively. It can be noted that three local peaks were registered in Belarus: 10-14, 40-44, 65-69 years. In four Russian oblasts integrated age-related rates had maximal value for the age of 45-49 years, further the rates lowered except some local ups. The most important distinction between age-related sets of the rates in Russia and Belarus was the lack of the peak in the age group of 10-14 in Russia, which is characteristic of Belarus.

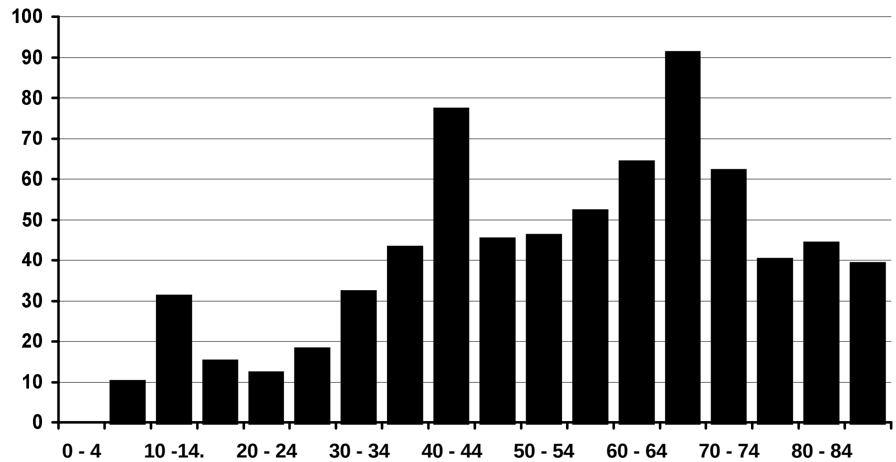


Fig. 6. The mean annual accumulated age-related thyroid cancer incidence rates (per 1 million people) in Belarus for the period from 1982 to 1997.

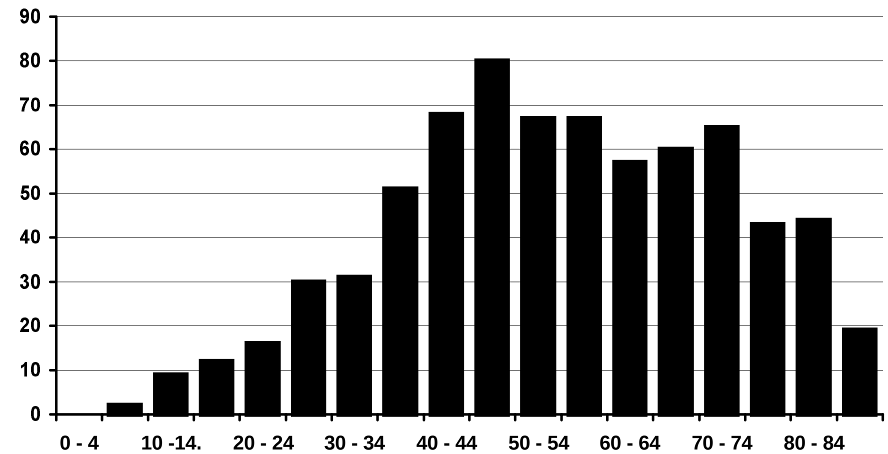


Fig. 7. The mean annual accumulated age-related thyroid cancer incidence rates (per 1 million people) in four mostly contaminated oblasts of Russia for the period from 1982 to 1997.

It is usual in radiation epidemiology to analyze the data with regard to the age at exposure rather than the age at diagnosis. In figure 9 the relationship between the age at the time of the Chernobyl accident and thyroid cancer incidence rate is shown. Firstly, the peak at the age of 0-4 years and minimum at the age of 10-14 years should be noted. It is interesting that there were a local minimum at the age of 40-44 years and two absolute peaks at ages of 35-39 and 45-49 years at exposure (72 and 73 people per 1 million people respectively).

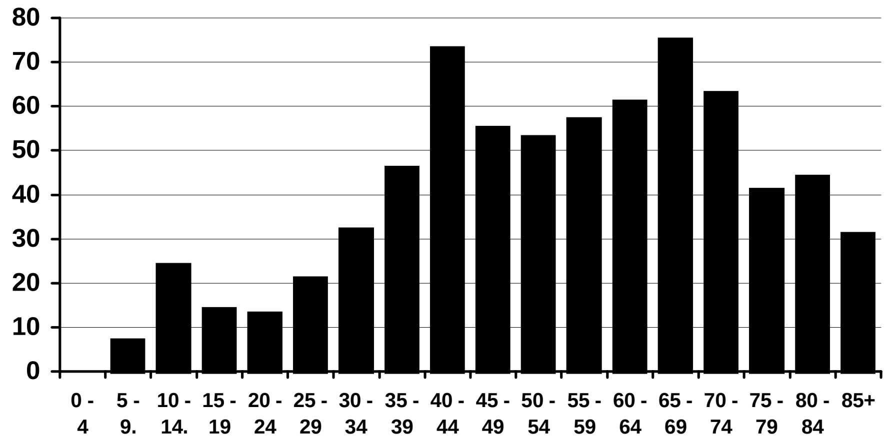


Fig. 8. The mean annual accumulated age-related thyroid cancer incidence rates (per 1 million people) in the Registry as a whole for the period from 1982 to 1997.

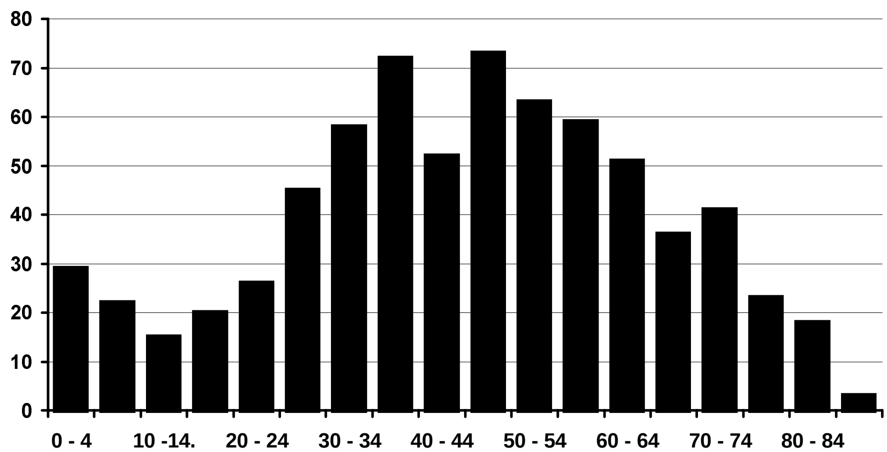


Fig. 9. The mean annual accumulated age-related thyroid cancer incidence rates (per 1 million people) in the Registry as a whole for the period from 1982 to 1997. Age at exposure.

In figures 10-12 incidence rates for the period from 1986 to 1997 in relation to the age at exposure are shown. For analysis the first six age groups – 0-4, 5-9, 10-14, 15-19, 20-24, 25-29 years were chosen. In the figure 10 it is seen that growth of the rate in all age groups was observed since 1990-1991. In the group 0-4 years the rate was stable and higher than the rates in other age-groups, in the group of 25-29 years at exposure only the rates correspond to the magnitude. In 1997 the rate in the group of 0-4 years was 87 per 1 million people. The peak of the rate in the group of 5-9 years was registered in 1993 (60 per 1 million people), further (1994-1997) it lowered, it was 31 per 1 million people in 1997.

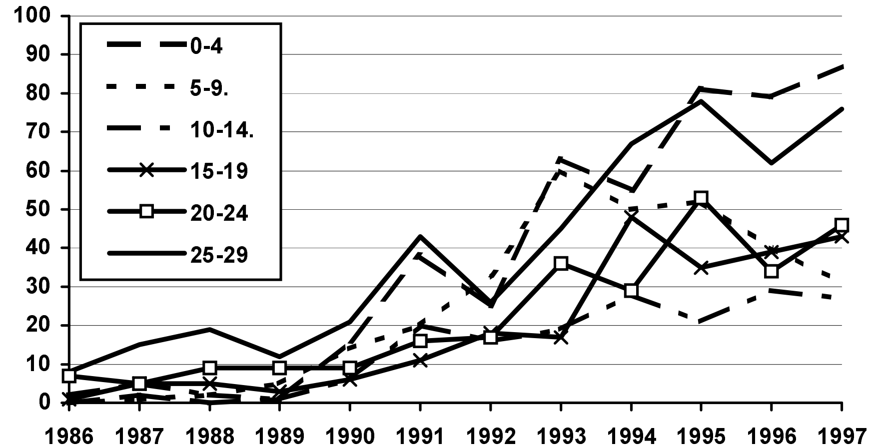


Fig. 10. The temporal variations of the age-related thyroid cancer incidence rate per 1 million people of Belarus. The different lines show the age at the time of the accident.

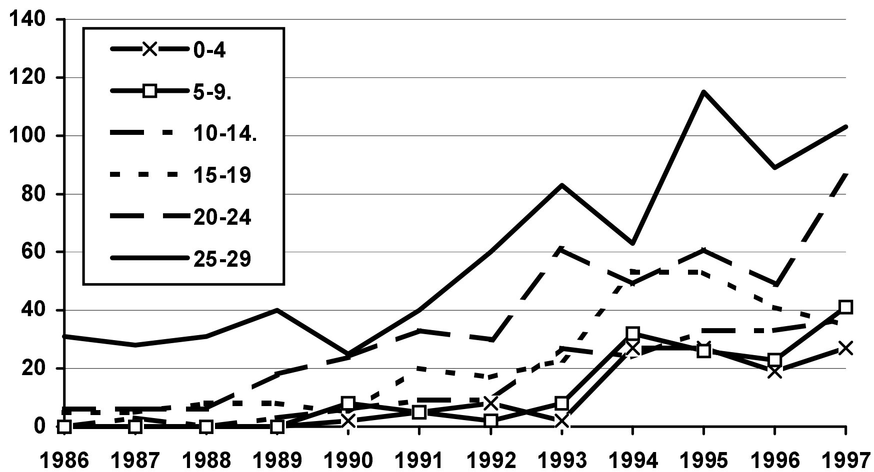


Fig. 11. The temporal variations of the age-related thyroid cancer incidence rate per 1 million people. 4 mostly contaminated oblasts of Russia. The lines are for the age at the time of the accident.

Figure 11 shows changes of age-related rates (age at the accident) in 4 Russian oblasts as a whole. It can be noted that dynamics is quite different from that observed in Belarus (fig. 10). First, there was not excess of the rate in the group of 0-4 years over the rates observed in groups 5-9, 10-14, 15-19, 20-24 years. The rates were related to the age at the accident. The rate did not drop in the group of 5-9 years after 1993, though the sharp increase in the rate since 1994 stopped. The sharp growth of the majority of the rates in the groups was observed in 1993-1994, it delayed compared with Belarus data by 2-3 years. When analyzing joint data of the Registry (fig. 12) one can see that for the whole time-period before and after the accident age group of 25-29 years was at the first rank, the group of 0-14 years was at the last rank, with the exception of 2-3 years. From 1995 to 1997 the group of 0-4 years at the accident was at the second rank.

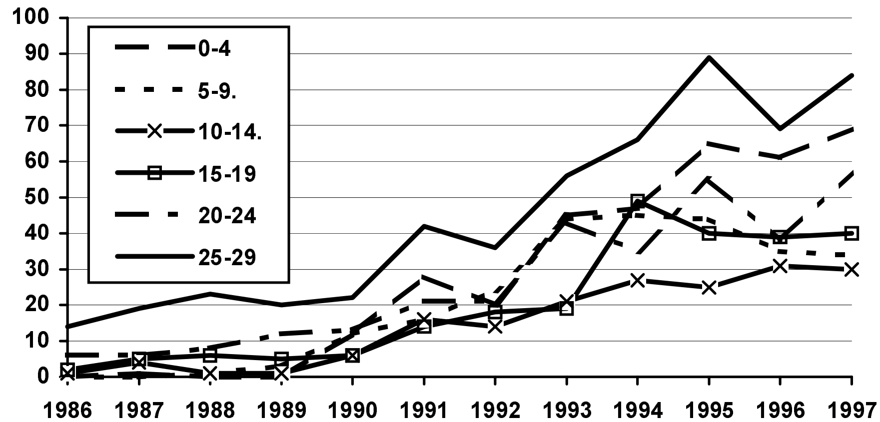
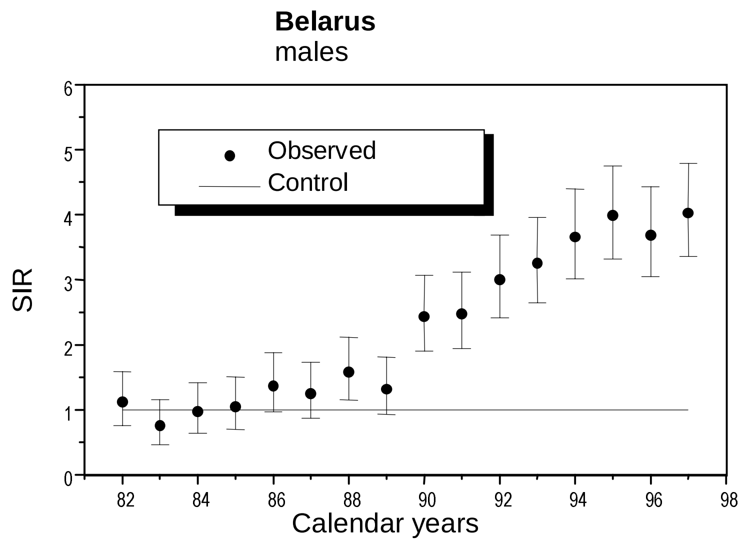


Fig. 12. The temporal variations of the age-related thyroid cancer incidence rate per 1 million people for the Registry as a whole.
The lines are for the age at the time of the accident.

The second part of this section presents results of the analysis of data with epidemiological indicators as SIR (Standardized Incidence Ratio – which is the relation of observed incidence rate among the population under study to expected incidence rate estimated with the use of age distribution of the population and age-specific incidence rates among control population (indirect standardization)). The indicator reflects the distinction between observed level of incidence in the population under study and the level of incidence in an equivalent population in a country as a whole (or in any control population) most unambiguously. The SIR shows the ratio between the level of incidence in a group under study and in the control group (in our study, the age-related rates in the state as a whole at the time of the accident are used as the “control”). In the study the so called indirect standardization was used, meaning that the age distribution of the population under study was accepted as the standard. The age distribution in relevant oblasts of Russia and Belarus was used.

In figure 13, the temporal variations of the SIR of thyroid cancer in males and females of the Republic of Belarus are shown (control level is unity). The SIR is about the same in males and females. From 1986 a statistically insignificant “jump” of the SIR was observed among males. A statistically significant “jump” occurred among females in 1987. The excess of the SIR was about 40-50%. For the next four years a “plateau“ both in males and females was observed; beyond that time is a strong, practically permanent increase. In 1997 in males the SIR increased by more than a factor of 4, in females the factor was 4.8. The portion of detected thyroid cancer cases increased in 4.0 times (males) as compared with the pre-accident period, and in females it was 4.8.



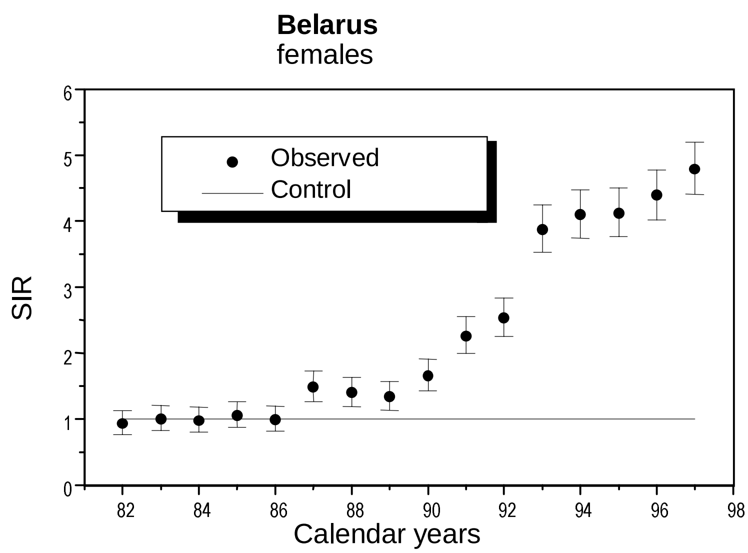
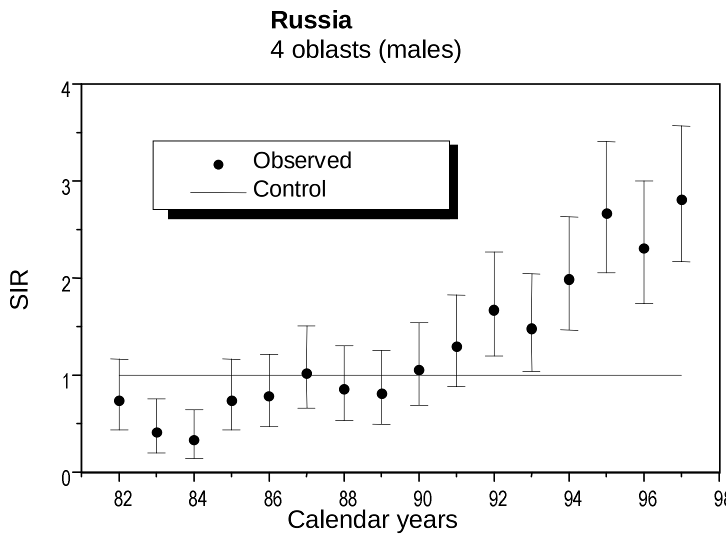


Fig. 13. The temporal variations of the SIR of thyroid cancer in males and females from 1982 to 1997. Republic of Belarus.

The situation in Russia was similar to that in Belarus. The temporal variations of the SIR in males and females was similar to the Belarussian, except some features (fig. 14). A significant increase in SIR in males and females was observed from 1992. To 1997 the value of SIR in males was over 2.8, in females it was 3.0. It should be noted that before the accident mean value of SIR in both males and females was lower the baseline. If the excess of detected thyroid cancer in 1997 is corrected to the mean SIR before the accident one can state that to the present time the rate of detected thyroid cancer in males living in 4 contaminated oblasts of Russia increased 5.6 times, and in females increased 3.7 times compared with the pre-accident period.



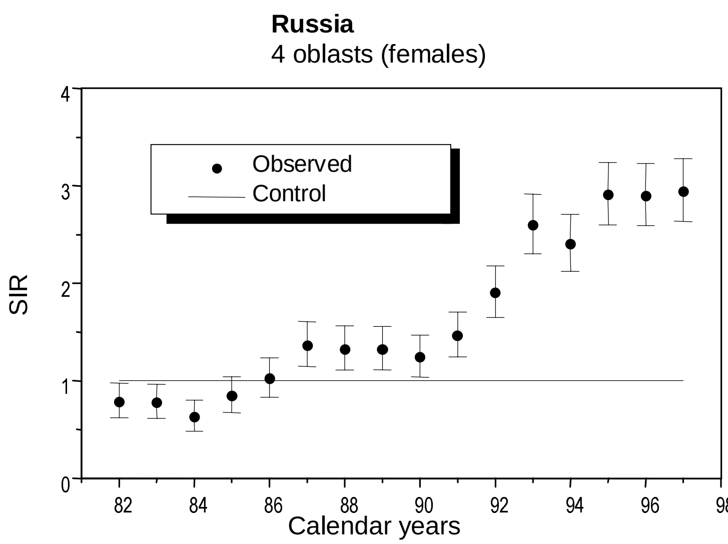


Fig. 14. The temporal variations of the SIR of thyroid cancer in males and females from 1982 to 1997. Four contaminated oblasts of Russia.

In figures 15-20 the temporal variations of SIR in males and females at the oblast level of the Republic of Belarus are shown. First we note that in 1997 the highest values of SIR in males and females were registered in Minsk and Gomel oblasts (in Minsk - 8.8 and 12.1, in Gomel - 8.9 and 7.0 in males and females respectively). It should be also stressed that before the accident, the SIR in those oblasts was higher than the national baseline. If excess of detected thyroid cancer in 1997 is corrected with regard to the mean SIR before the accident, the fraction of detected thyroid cancer in males of the Minsk oblast has increased 3.5 times, and among females 4.5 times compared with the pre-accident period; in the Gomel oblast the factor was 5.9 in males; and in females it was 7 compared to the SIR before the accident.

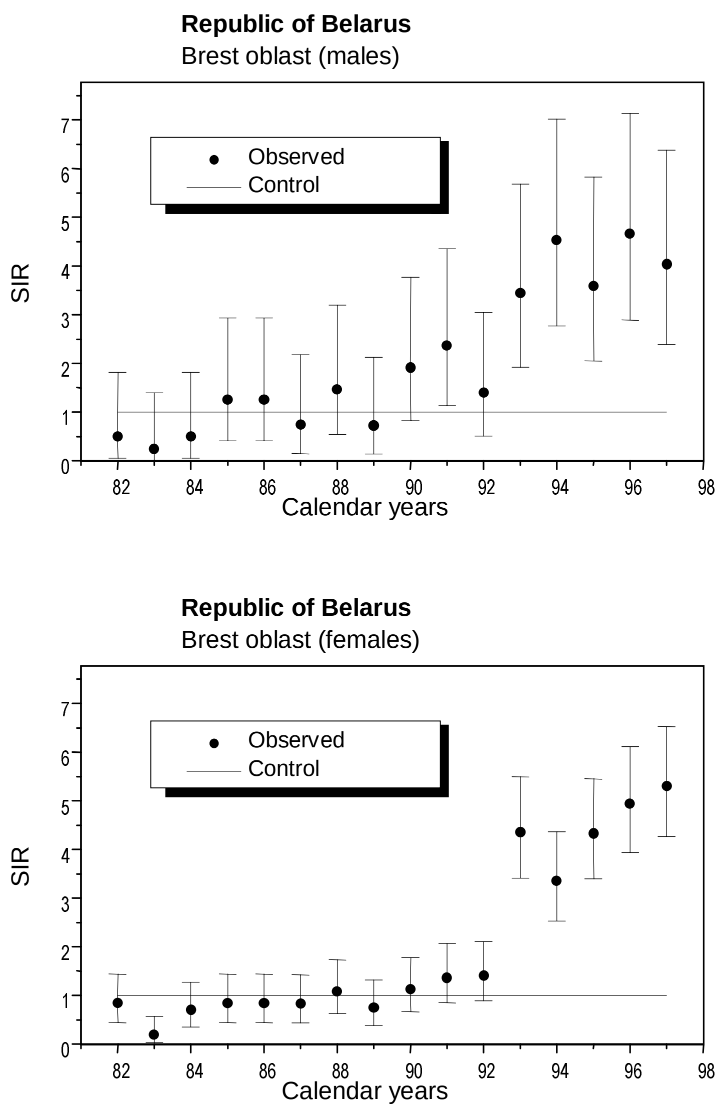


Fig. 15. The temporal variations of the SIR of thyroid cancer in males and females from 1982 to 1997. Brest oblast, Republic of Belarus.

Minimal changes in the SIR after the accident were observed in the Grodno oblast; in this oblast in 1994 the SIR in males was 2.7, the excess was significant. In the last three years the SIR was about 1.8. A similar picture is seen in females, though a statistically significant excess of SIR over 1 was observed from 1991 through 1996. The highest SIR in females was in 1994 (3.5), afterwards it lowered to 1.3 (insignificant excess over 1). The sharpest increase in the SIR in females was in Brest and Vitebsk oblasts in 1997 (5.3 and 5.4 respectively).

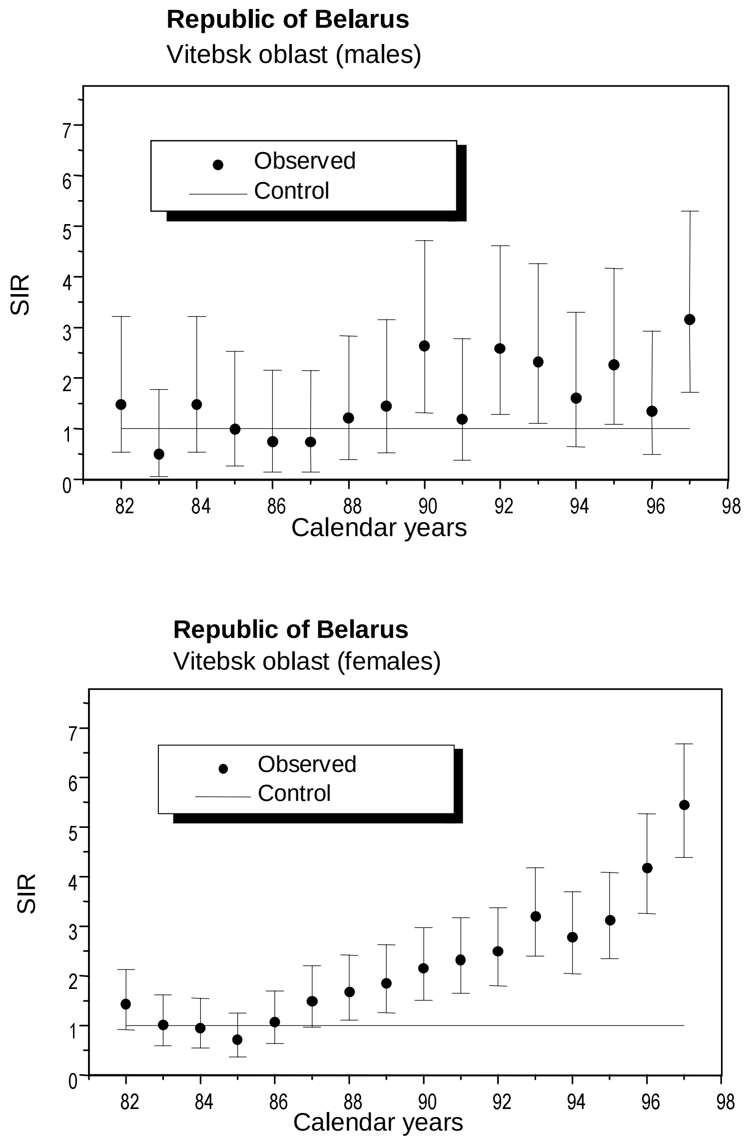
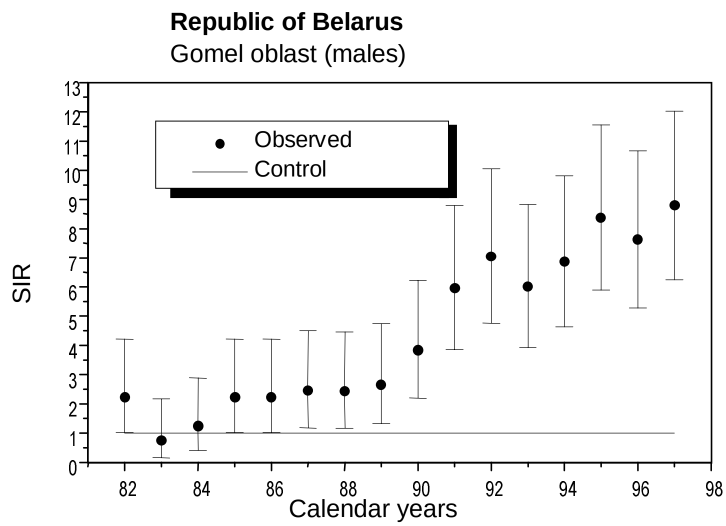


Fig. 16. The temporal variations of the SIR of thyroid cancer in males and females from 1982 to 1997. Vitebsk oblast, Republic of Belarus.

We must pay special attention to the observed increase in the SIR in the Mogiliov oblast; only in 1995 a significant excess of the SIR in males (over 1) was observed (SIR=2.8), afterwards it fell to 1. We must take into account that before the accident SIR in this oblast was not higher than 0.5. If the excess of SIR over 1 is corrected with regard to mean SIR before the accident one can state that to 1994 the portion of detected thyroid cancer increased in 6.1 times as compared with the pre-accident period. The similar picture was seen in females, though in 1995 in females dropping of SIR was not found, in 1997 only SIR dropped slightly. If excess of SIR over 1 is corrected with regard to mean SIR before the accident one can state that to 1996 (maximal SIR) the portion of detected thyroid cancer increased in 4.1 times as compared with the pre-accident period.



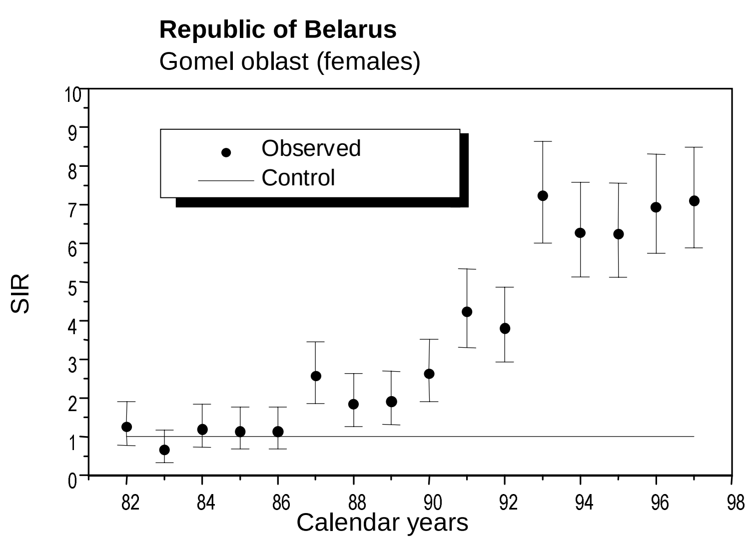
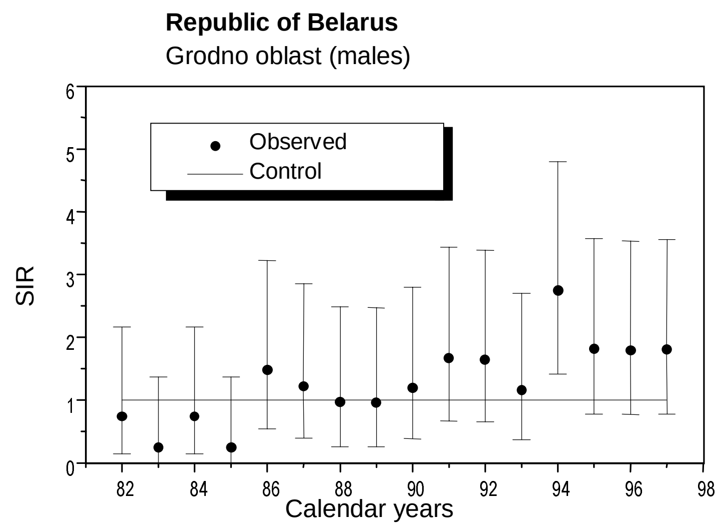


Fig. 17. The temporal variations of the SIR of thyroid cancer in males and females from 1982 to 1997. Gomel oblast, Republic of Belarus.



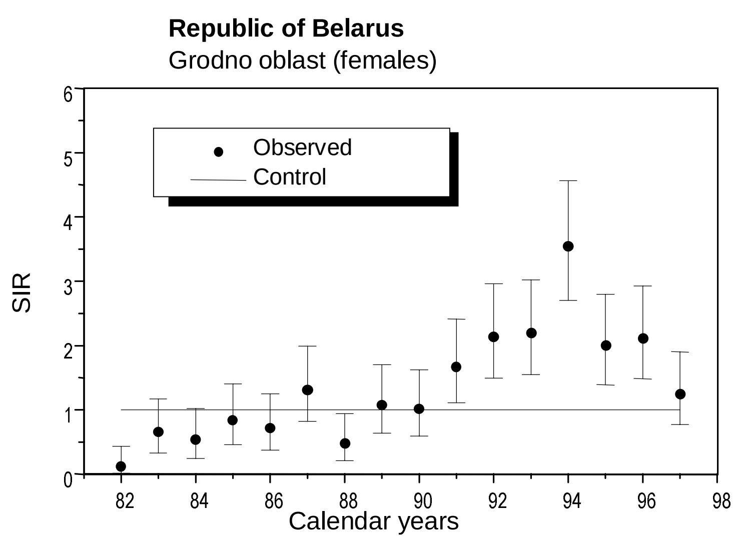
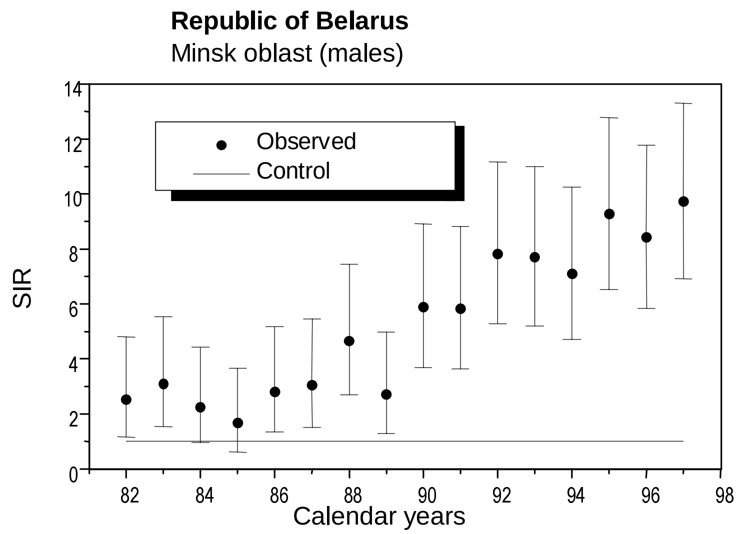


Fig. 18. The temporal variations of the SIR of thyroid cancer in males and females from 1982 to 1997. Grodno oblast, Republic of Belarus.



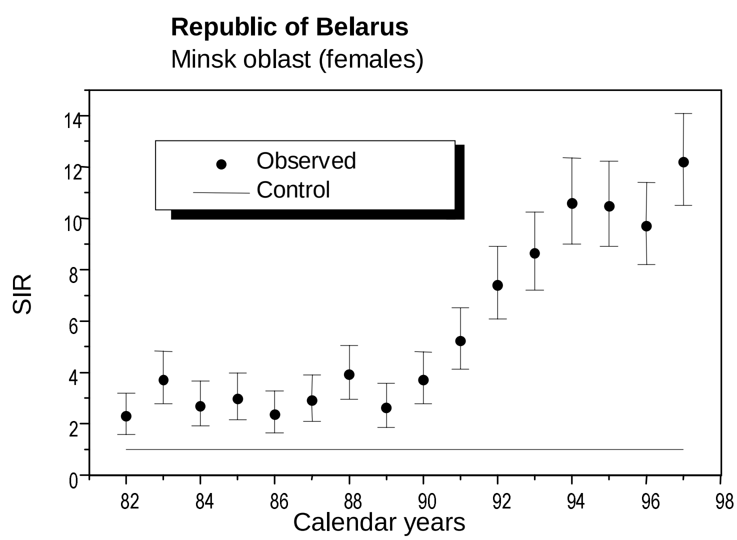
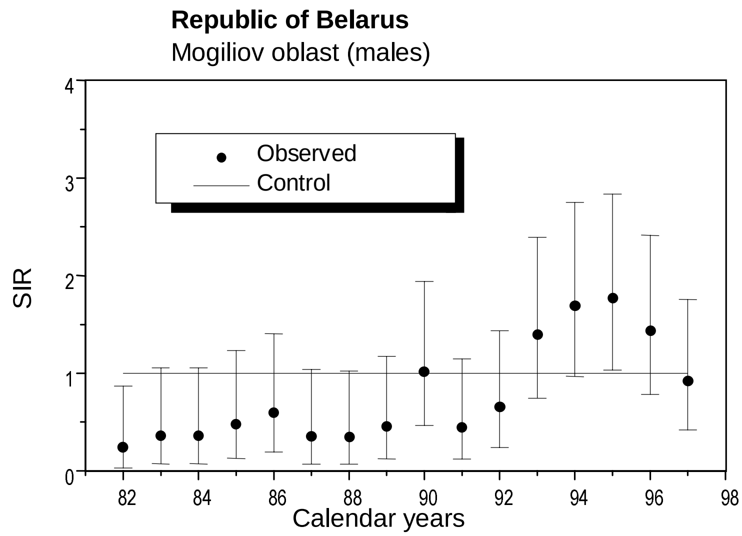


Fig. 19. The temporal variations of the SIR of thyroid cancer in males and females from 1982 to 1997. Minsk oblast, Republic of Belarus.



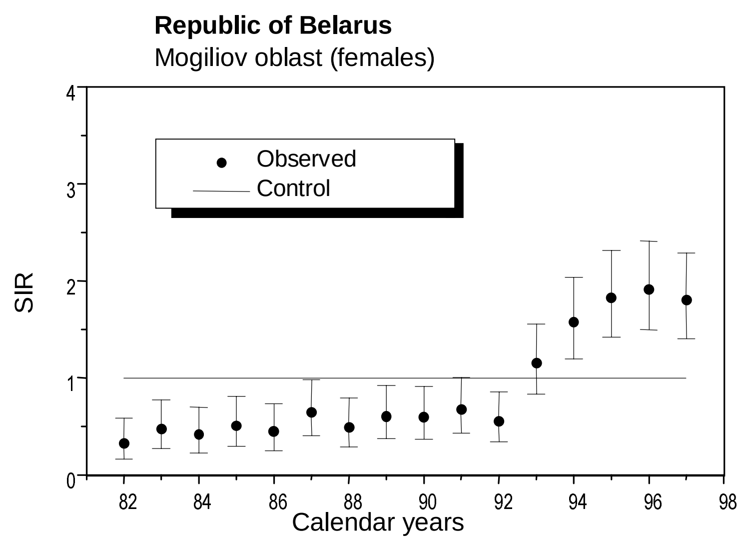


Fig. 20. The temporal variations of the SIR of thyroid cancer in males and females from 1982 to 1997. Mogiliov oblast, Republic of Belarus.

Figures 21-24 show the temporal variations of the SIR in males and females of the 4 most contaminated oblasts of Russia (Tula, Oriol, Bryansk and Kaluga). One can primarily state that with regard to the amplitude of SIR in 1997 in both males and females the leaders were Bryansk and Oriol oblasts (Bryansk - 3.9 and 3.2, Oriol - 3.6 and 5.4 in males and females respectively). At the same time before the accident in all of the above oblasts SIR was lower than the baseline. If SIR is corrected with regard to mean SIR before the accident one can state that in 1997 achieved excess of SIR was

4.9 in males and 6.4 in females of the Bryansk oblast as compared with the pre-accident period, in the Oriol oblast it was 4.5 and 6.8 respectively.

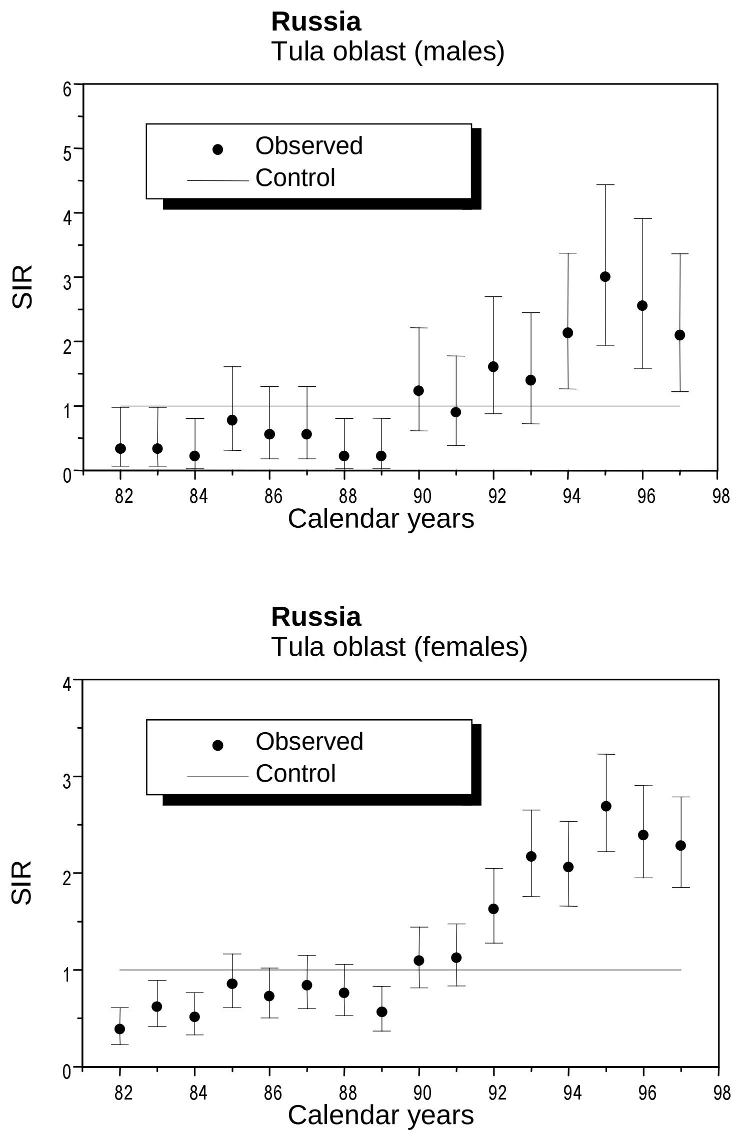
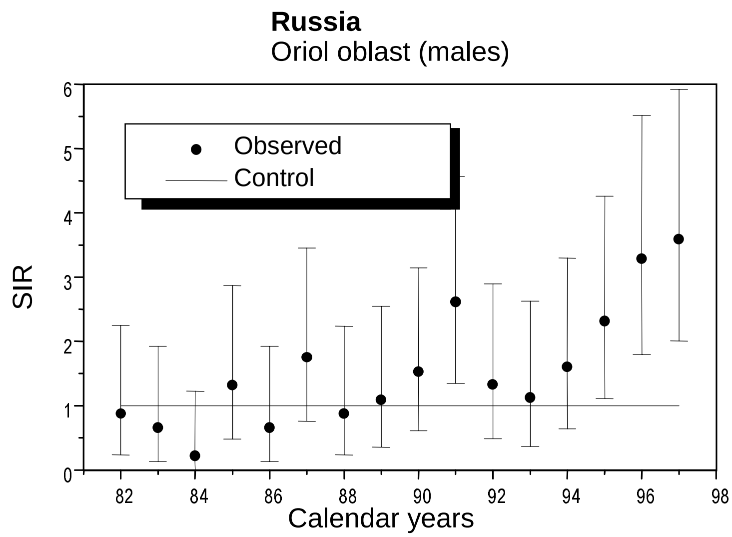


Fig. 21. The temporal variations of the SIR of thyroid cancer in males and females from 1982 to 1997. Tula oblast, Russia.

In the Tula oblast increase in SIR was observed as well; the distinction between Tula's SIR and that in the Bryansk and Oriol oblasts was in the that the peak of SIR in both males and females was in 1995 (SIR - 3.0 and 2.7 in males and females respectively). After correction (similar to that described earlier) with regard to mean SIR before the accident one can state that in 1995 ("peak" year) the portion of detected thyroid cancer increased in 6.0 times in males and 4.5 in females as compared with the pre-accident period. To 1997 SIR lowered to 2.0 and 2.2 in males and females respectively; the excess over 1 was statistically insignificant.



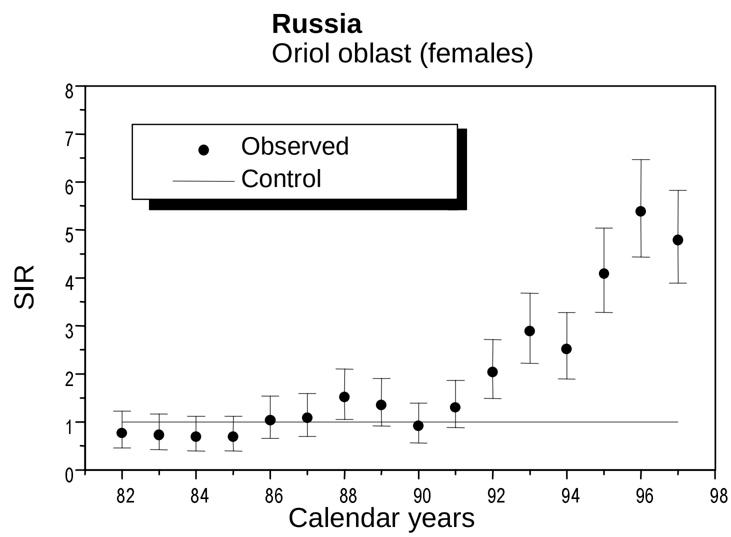
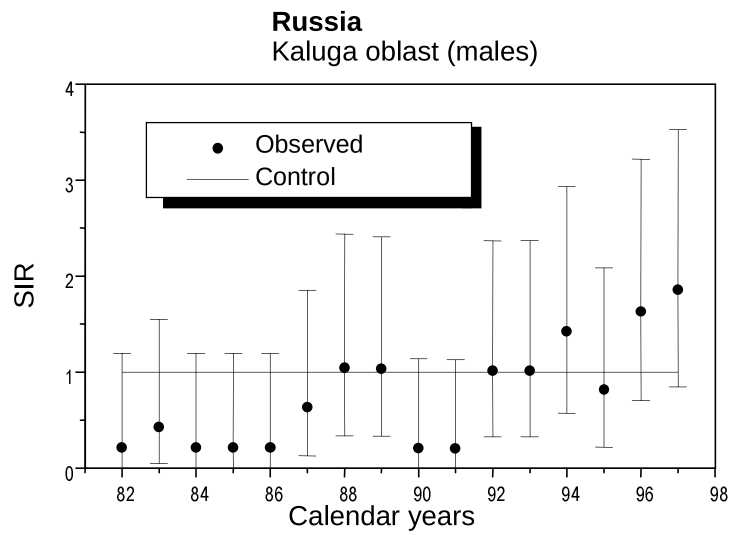


Fig. 22. The temporal variations of the SIR of thyroid cancer in males and females from 1982 to 1997. Oriol oblast, Russia.



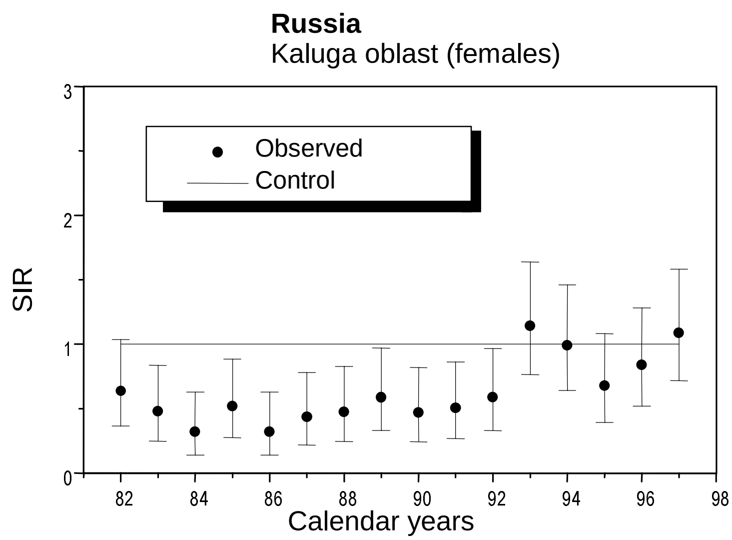


Fig. 23. The temporal variations of the SIR of thyroid cancer in males and females from 1982 to 1997. Kaluga oblast, Russia.

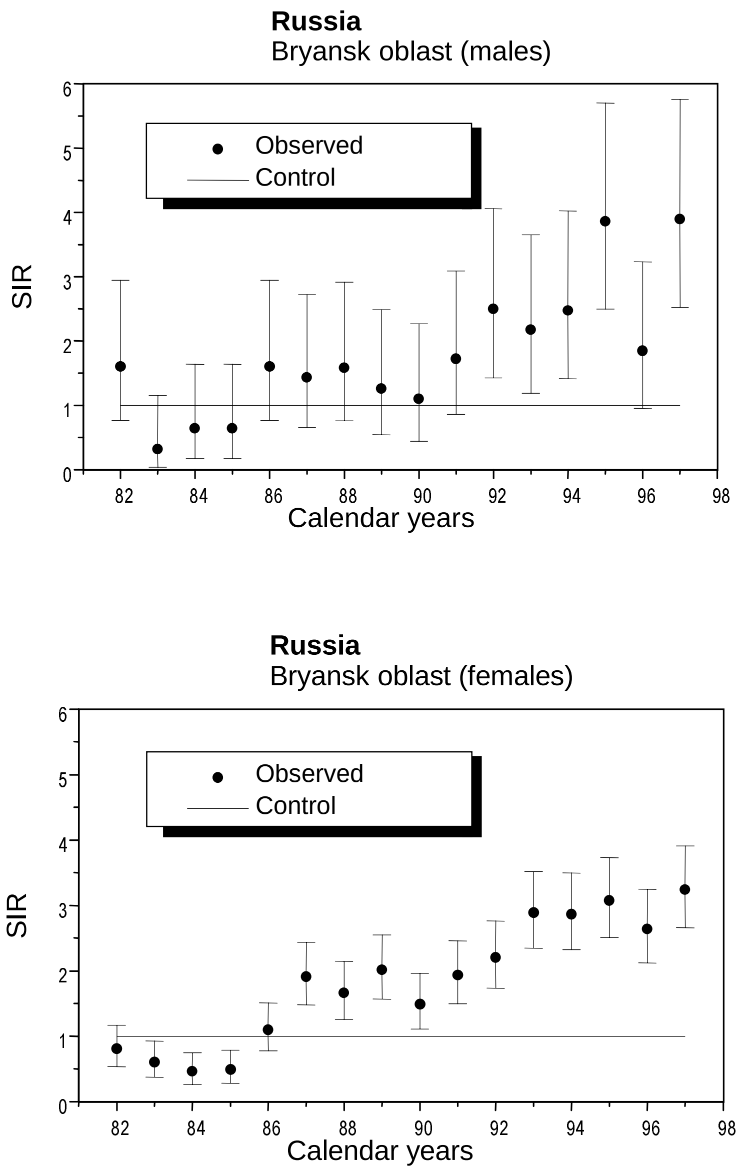


Fig. 24. The temporal variations of the SIR of thyroid cancer in males and females from 1982 to 1997. Bryansk oblast, Russia.

In conclusion we must pay attention to the picture in the Kaluga oblast. It is seen (fig. 23) that for the whole period of follow-up SIR was not over 1 (statistically significant). Before the accident the portion of detected thyroid cancer in males and females was significantly lower than that in Russia. In 1994 SIR in males and in 1993 SIR in females first was over 1. To 1997 SIR was 1.8 and 1.1 in males and females respectively. However, if the SIR values were corrected with regard to those before the accident, the excess of the SIR becomes 6.0 in males and 2.8 in females in 1997.

The following conclusions may be drawn:

- In the Registry as a whole the number of detected thyroid cancer cases increased after 1986, for the following three years, however, the achieved number remained at the same level (350-370 cases a year).
- From 1990 a sharp increase in the overall number of detected thyroid cancer cases was observed. The number was 1100 in 1997, which was 4.5 times higher than observed in the period before the accident.
- The most dramatic increase in the number of detected thyroid cancer cases before and after the accident, especially after 1992 was observed in the age group of 10-14 years (more than 50 times the number in the pre-accident period (1982-1986)).
- From 1991 the Gomel oblast was at the first rank in Belarus with regard to thyroid cancer incidence (in 1997 it was 94 cases per 1 million people). From 1993 the Brest oblast was permanently at the 2nd and 3rd rank, though it was not the most contaminated area. In Russia the Bryansk oblast had been at the first rank from 1986 to 1994. However, from 1995 to 1997 Oriol oblast was at the first rank among Russia's oblasts, in 1996 the Oriol oblast was leader among Russia's and Belarussia's oblasts, in 1996 the highest rate was registered there (140 per 1 million people).
- In the group of 0-4 years at the accident the incidence rate in Belarus was higher compared with the other age groups (5-9; 10-14; 15-19; 20-24 years at the accident). In the Russian part of the registry such effect was not found.
- In Belarus the rate of detection of thyroid cancer (with regard to age-specific features) increased 4 times in males and 4.8 times in females as compared with the period before the accident. In four mostly contaminated Russia's oblasts rate of detection of thyroid cancer increased in 5.6 and 3.7 times in males and females respectively with regard to mean SIR before the accident.