Incidence of Childhood Disease in Belarus Associated with the Chernobyl Accident

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Study of the childhood incidence of cancer and other diseases in Belarus is of great importance because of the present unfavorable environmental situation. About 20% of the children in the republic were exposed in various degrees to radiation as a result of the Chernobyl accident. Since 1987 increases in the incidence of most classes of disease have been reported, including the development of thyroid cancer. From 1987 to 1995, thyroid cancer was diagnosed in 424 children; its incidence having increased from 0.2 to 4.0/10^5 in 1995. According to preliminary data for 1996, 81 childhood cancer cases were reported. During 1995 there also were increases in the incidence of endocrine and dermatologic diseases and mental disorders. During the period 1987 to 1995 significant increases in the incidences of all illnesses were observed for children listed in the Chernobyl registry. The highest incidence rates were found in evacuated children and those residing in contaminated areas. There also were increased incidences of thyroid and digestive organ diseases among these children and in addition, high prevalence of chronic tonsillitis and adenoiditis was observed. Since 1990 an increase of autoimmune thyroiditis has been observed. The highest rates of hematopoietic tissue diseases were found in children born after the accident to irradiated parents. — *Environ Health Perspect* 105(Suppl 6):1529–1532 (1997)

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Introduction

The childhood incidence of cancer and other diseases in Belarus may have been affected by environmental contamination that occurred after the Chernobyl accident. Almost all children in the republic were exposed to radioactive iodines, mainly ^{131}I. About 20% of children in Belarus resided, and most still live in, regions contaminated by more than 37 kBq/m^2 of ^{137}Cs (> 1 Ci/km^2) where they were exposed to various levels of radiation as a result of the Chernobyl accident. At present about 10,000 children reside in areas with ^{137}Cs ground contamination higher than 555 kBq/m^2 > 15 Ci/km^2, about 79,000 reside in areas contaminated with 185 to 555 kBq/m^2 (5–15 Ci/km^2), and about 359,000 children reside in regions contaminated with 37 to 185 kBq/m^2 (1–5 Ci/km^2).

Health consequences of this accident have included a rising incidence of thyroid cancer in children (*1–3*). In addition, the social and psychological stresses that followed the accident were significant and long lasting (*4,5*). A rise in serum levels of clastogenic factor in Belarusian children also has been reported (*6*).

Radiation exposure may have influenced disease incidence rates in the republic both quantitatively and qualitatively. The worsening of childhood health status has been accompanied by unfavorable demographic changes (Figure 1): Since 1988 a decrease in the birth rate has been observed (16.1 births/1000 in 1988, 9.8/1000 in 1995, and 9.3/1000 in 1996). Since 1991, infant mortality has increased (12.05/1000 in 1991 and 13.3/1000 in 1995). According to World Health Organization (WHO) figures the mortality of low-birth-weight infants was 14.8/1000 in 1994. In 1993 a negative population growth was registered for the first time (–1.1/1000), and this trend has continued (–1.9/1000 in 1994, –3.2/1000 in 1995, and –3.7/1000 in 1996).

During the period 1987 to 1995 an increase in both the incidence and prevalence of morbidity was registered for most disease classes. This includes a growth in the incidence of malignant neoplasms per 100,000 children from 9.9 in 1986, to 15.4 in 1994, to 15.8 in 1995. There now is little doubt that the increased thyroid cancer incidence in the children of Belarus was caused by the Chernobyl accident. Over the period 1986 to 1995, thyroid cancer was diagnosed in 424 children, a rate of increase from 0.2/10^5 in 1986, to 3.5/10^5 in 1994, and 4.0/10^5 in 1995. According to preliminary data from 1996, 81 childhood cancer cases were recorded that year. An increase in brain cancer incidence among children was also observed. According to several different authors there has been no significant increase in leukaemia among children (*7,8*). Belarusian national statistics on the incidence of other systemic diseases among children for the period of 1988 to 1995 show increases as noted: digestive conditions, 1.9-fold; dermatological diseases, 2.9-fold; mental disorders, 3.0-fold; hematological diseases, 2.1-fold; circulatory diseases, 2.5-fold; and nervous disorders, 3.3-fold. Data on nonneoplastic thyroid diseases have been registered since 1992; over the period 1992 to 1995 they increased by 1.1-fold.

Studying the health effects of the Chernobyl accident is of great importance to the world community as well as to Belarus because stochastic and nonstochastic effects of radiation exposure and other factors of the accident may be evaluated by monitoring the health status of large groups among the affected population.

The Chernobyl Registry

In recent decades analysis of population health status, including that of children, has been carried out with the help of special registries. In the Republic of Belarus the State Registry of Population Exposed to Radiation as a Result of the Chernobyl Accident (Chernobyl registry) was initiated in 1986. The registry was created to provide information required to organize special follow-up, health care, and rehabilitation

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Abbreviations used: BelCMT, Belarus Center for Medical Technologies; Ci, curie; HCI, health care institutions; ICD, *International Classification of Diseases*; kBq, kilobecquerel; WHO, World Health Organization.

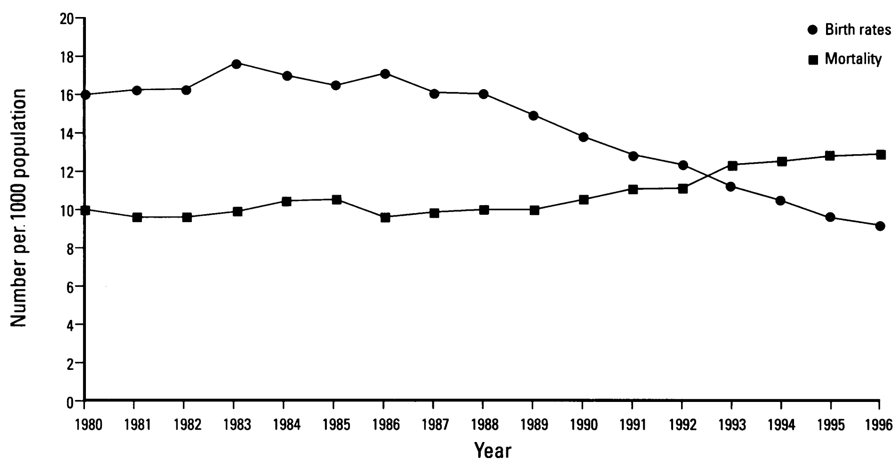

Figure 1. Annual birth rate and mortality per 1000 population in the Republic of Belarus.

services; to study time trends and disease outcomes in the follow-up populations in various regions of Belarus; to define risk groups and to assess the effectiveness of rehabilitation procedures on population health; and to prepare recommendations on prevention, diagnosis, and treatment of the diseases as well as on the improvement of health care for affected populations.

The Chernobyl Registry of Belarus is a multilevel system for collecting information from the national, regional (oblast), and district (rayon) levels as well as from health care institutions (HCI) in the entire republic. The main units within which registry activities are conducted are the departments at the rayon levels, which are responsible for follow-up studies. Primary health data for affected populations are collected and introduced into the database at these levels. At the oblast level the rayon databases are incorporated into regional databanks. The oblast registry departments also control the activities of the rayon registries to ensure timely data collection and quality. At the national level, the Chernobyl registry is located at the Belarusian Center for Medical Technologies (BelCMT), where special registry software has been designed and introduced, medical, organizational, and technical recommendations are prepared, scientific data are analyzed, and the direction of activities at the oblast and rayon levels is determined.

It is particularly important to obtain information about children because they are presumed to be more sensitive than adults to the effects of radiation exposure. A subregistry for children was therefore initiated in 1992 based on the main Chernobyl registry. Bearing in mind that follow-ups of children differ from those of adults, a new version of the questionnaire—medical history of the child—was designed in collaboration with the Institute for Mother and Child Health Protection (Minsk, Belarus). This document made possible data required for analyzing health status, morbidity, follow-up, and the effectiveness of health rehabilitation for exposed children. It provided information summarizing the primary registration and health groups as well as medical, residential, and demographic data. Primary health data on children to be registered in the Chernobyl registry are collected by the HCI on specially designed documents used for primary registration, collection of dosimetry data, and entry of follow-up results. Stages in the process of data collection and follow-up for children exposed to radiation include identification, registration, and collection of annual medical examination results.

Verifications of the diagnoses included in the registry are made on the basis of a child's medical history and include the following steps.

- The final diagnosis in the list of diagnoses is verified from the child's medical history.
- The final diagnosis in the registry is verified from the list of diagnoses.
- The coding correctness is checked.

The main statistical data used for data analysis were: primary registration group, sex, age, place of residence, health group, clinical diagnosis (including whether the condition is acute or chronic and of recent onset, or known before), rehabilitation (type, result), and prevalence and causes of disability or death.

A set of output forms was also designed and has been used to analyze demographic, exposure, and clinical data on children included in the Chernobyl registry. The output forms were used to analyze data obtained from follow-up groups of registered children according to sex and age, geographic territory, time period of exposure, and other parameters. The following information was obtained:

- Distribution of registered children according to sex and age in the primary registration groups and in groups classified by health status, social aspects, and disability.
- Reasons for continued residence in contaminated areas.
- Data on the follow-up and medical examinations of children.
- Data on morbidity and mortality, based on the *International Classification of Diseases* (*ICD-9*) disease classification.
- Personal data on children according to various criteria.
- Distribution of children according to dose estimates.
- Lists of children and adolescents under follow-up by the HCI.
- Lists of children who have died.

The special output forms have made possible the following:

- Assessment of the health status on a timely basis and analysis of follow-up results of children according to territorial or other statistical groups.
- Preparation of summary output data in the form of tables, maps, and figures.
- Summary of multiple data-processing results for decision making.

Data on 65,000 children are stored in the Chernobyl registry. This includes more than 32,000 children 0 to 14 years of age at the end of 1995. They have been subdivided into the following sets:

- Set 1, children evacuated from a 30-km area around Chernobyl, 5.4%.
- Set 2, children residing in or who moved from areas with radioactive contamination higher than 15 Ci/km^2, 63.4%.
- Set 3, children born to parents exposed to radiation (i.e., liquidators, evacuees from the 30-km zone surrounding Chernobyl, and people resettled from areas with ^{137}Cs ground contamination > 555 kBq/m^2 (or > 15 Ci/km^2), 31.2%.

These sets represent the second, third, and fourth groups in the Chernobyl Registry, respectively; the first group includes the liquidators.

Sources of Comparison Data, Public Health Statistics, and Assessment of Outcome

Information on childhood incidence of disease in Belarus was obtained from official reports of the Belarus Ministry of Health (*9*). This organization collects and organizes data on morbidity from all HCIs in the republic coded according to the *ICD-9*. The staff of BelCMT constantly checks and verifies diagnoses entered in the registry. All cancer diagnoses in children registered in the Chernobyl registry are verified and all such children are examined and followed up by oncological clinics registered with the Belarusian Cancer Registry.

Age adjustment of the rates was not carried out for the Chernobyl registry data because it was not available for the general incidence data for children of Belarus. Until 1996 the incidence was registered for all children 0 to 14 years of age without further differentiation. However, beginning in 1997, a new report form was to be introduced to register incidence in different age groups. The same was to be done Chernobyl registry data. During the period 1988 to 1996 covered by this report, disease incidence data on the children of Belarus were sent to the Ministry of Health on a common form adopted by all the HCIs in the republic.

Results

Even now, the children most exposed to radiation still reside in the Gomel (55.1%) and Mogilev (11.5%) regions. During the period from 1986 to 1995, an increase in both the incidence and prevalence of childhood morbidity was recorded in the Chernobyl registry. This was observed for most disease classes, with higher rates than in Belarus.

Cancer

The cancer incidence rate for children registered in the Chernobyl registry during 1995 was $22.5/10^5$; the 5-year (1991–1995) rate was $17.5/10^5$. Since 1989 an increase in thyroid cancer has been recorded for the exposed children. During the period 1986 to 1995 thyroid cancer was diagnosed in 41 children and 10 adolescents from the cohort of children registered in the Chernobyl registry and exposed to radiation in childhood (about 65,000 children). Of these, 13 children had been evacuated from the 30-km area surrounding Chernobyl. Most of the affected children were 0 to 4 years of age at the time of the accident.

Nonneoplastic Conditions

Digestive Diseases. Diseases of digestive organs have had the second highest prevalence since 1992. In 1995 the highest rates were registered among children of the second group ($10,811/10^5$ children); these incidence rates were 2.4 times higher than the rates in Belarus as a whole (Figure 2). Most frequent among these conditions were gastritis and gastroduodenitis; an increased incidence of bile duct pathology was also recorded.

Endocrine Diseases. Children in all registry groups experienced statistically significant growth in incidence and prevalence of endocrine diseases. The risk of thyroid disease is 3.8 times higher than the national average in Belarus. Since 1990 an increase in thyroiditis has been registered, with half the cases being autoimmune (Hashimoto's chronic lymphocytic thyroiditis). The incidence rates in 1995 were $75.5/10^5$; the national average was $19.8/10^5$. High rates of nodular goiter were also registered—$113.3/10^2$ among the registry groups and $47.4/10^5$ nationally.

Anemia. During the period 1995 to 1996 an increase of anemia was registered for all registry groups. This may be associated with nutritional deterioration. The finding may partially be the result of improved surveillance of the affected children. Especially high rates were observed in children born after the Chernobyl accident of irradiated parents. The risk of anemia for these registered children is 2.8-fold higher than average national rates ($1070.0/10^5$ children).

Nervous System Diseases. Diseases of the nervous system were most frequently registered among children of group 2; incidences were 1.3 times higher than the average national rates.

Respiratory Organ Diseases. With regard to diseases of respiratory organs, high rates of chronic tonsillitis and adenoiditis were found in children of all the registry groups.

Discussion

The highest levels of radiation exposure occurred among children of the Gomel region. These children were found to have the highest incidences of gastrointestinal, endocrine, and hematopoietic diseases as well as an increased incidence of thyroid cancer. In children of the Mogilev region diseases of the endocrine system had the second highest incidence and diseases of the digestive organs the third highest incidence. Recently, perhaps because of migration of populations from the contaminated areas, an increase in various diseases has been recorded among children from Minsk and the Minsk region.

Further research will require new approaches to data collection, processing, and analysis that should be based on international (WHO) standards. Modern

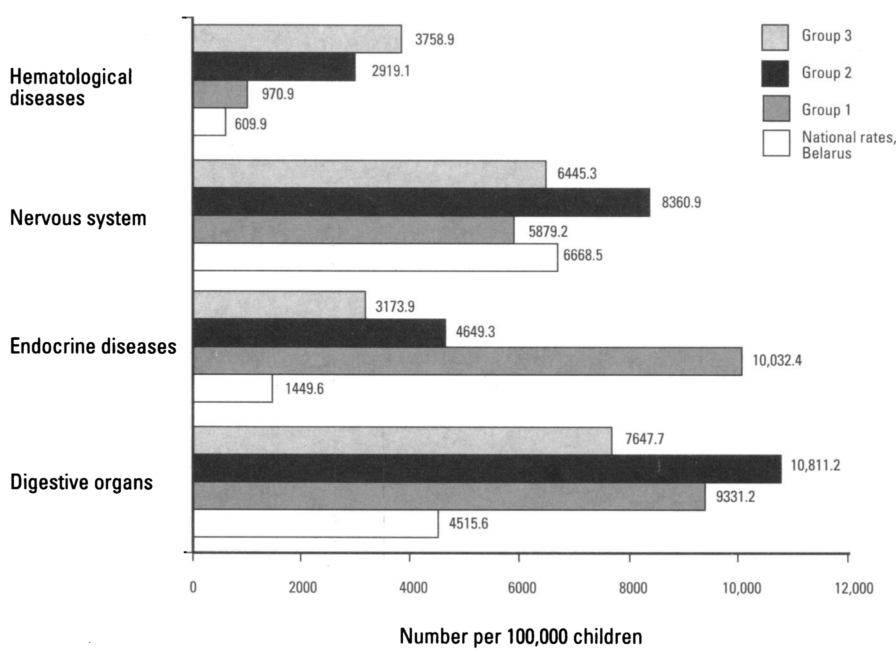

Figure 2. Incidence of some disease classes per 100,000 children during 1995 in the Chernobyl registry compared to the national average in Belarus.

developments in computer technology make it possible not only to carry out simple analyses of disease rates but also to prepare predictions for the future as required at decision-making levels and by practical HCIs. The preliminary results presented here are based on the Chernobyl registry data. These results need further checks and diagnosis verification; it would be useful to carry out case–control studies for some conditions. There is no doubt, however, that a general increase in morbidity is being observed in the children of Belarus for some disease classes.

At this stage we cannot reach definite conclusions because our data are only preliminary and need further careful verification and processing. We do not believe that all the health changes of Belrussian children were caused by radiation exposure. Indeed, only the thyroid cancer incidence increase in children of Belarus may with little doubt be considered induced by radiation. Notably, no rise in leukemia has been recorded. To understand some of the health changes observed it is necessary to investigate further the complex role of various environmental factors. Psychosocial factors are increasingly recognized to be important as well as the roles of lifestyle, diet, etc. The iatrogenic effect of intensified examination of the cohorts of exposed children cannot be overlooked, as this may have affected reporting of disease incidence. At present we are working on age standardization of the registry data and acquiring data on external exposure doses.

In conclusion, we emphasize that the findings described in this paper—elevated morbidity in several disease categories—cannot be ascribed only to radiation. The roles of improved surveillance of populations and psychosocial aspects as well as adverse nutritional and other environmental factors must also be evaluated.

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