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Research Article

Comparative Analysis of the Incidence of Thyroid Cancer for a 30-Year Period in Areas Contaminated With I-131 as a Result of Chernobyl Accident

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Abstract

In present study we analyzed the incidence of thyroid cancer in the districts of the Brest region over a 30-year period after the Chernobyl accident, in which in April 1986 the population received significant doses of radiation to thyroid gland due to the incorporation of I-131. The incidence of thyroid cancer in contaminated districts of the Brest region was compared to that in the Lepel district of the Vitebsk region, which was not contaminated with iodine isotopes. According to the cancer registry, there were 235 cases of thyroid cancer in Stolin and Luninets districts of the Brest region. The peaks of incidence in the Brest region were at 13 and 32 years after exposure. In contrast to this, in the "clean" region of Belarus, that is Vitebsk region, just one peak of incidence was clearly distinguished with a latency period of about 17 years. Among the residents of the Brest region, a group of patients stands out who were from 40 to 50 years old at the time of diagnosis. That is, this group received exposure to the thyroid gland due to I-131 at the age of 10-20 years. In contrast, in non-irradiated people living in the Vitebsk region, the cancer is more often diagnosed much later, at the age of about 60 years. The cumulative incidence in Stolin and Luninets districts of the Brest region was approximately two times higher than in the "clean" Lepel district of the Vitebsk region. The data obtained show that further analysis of morbidity should be carried out in comparison with radiation exposure, i.e. taking into account the doses to the thyroid gland in the study cohort.

ABBREVIATIONS

TC: Thyroid Cancer

INTRODUCTION

More than 30 years have passed since the accident at the Chernobyl nuclear power plant. The first confirmed effect of radiation on the population of Belarus was an increase in the number of thyroid cancer (TC) in children, which began in the early 90s of the last century [1-3]. One of the most important reasons for the appearance of this pathology was the impact of iodine radionuclides on the population (I-131, I-133, I-135, etc.). Iodine-131 plays a special role due to its physical characteristics. The intake of this radionuclide into the human body occurred in different ways: through inhalation due to the immersion of iodine in the air; alimentary, mainly due to the consumption of whole milk. I-131 accumulates exclusively in the thyroid gland, forming an absorbed dose in this organ [4]. Due to the lower mass of the thyroid gland and the peculiarities of metabolism, the accumulation of radioiodine in children can occur to a greater extent, which should lead to the formation of significantly higher absorbed doses [5].

Epidemiological studies of TC mainly concerned the residents of Gomel and Mogilev regions [6]. At the same time, other regions of Belarus were also contaminated with iodine. This includes the east of the Brest region, where Stolin and Luninets districts are distinguished because of the highest degree of pollution. Moreover, over the past 30 years after the accident, certain conclusions can be formulated.

Considering this, in the present study we analyzed the incidence of thyroid cancer in the mentioned districts of the Brest region over a 30-year period after the Chernobyl accident.

MATERIALS AND METHODS

Data on the incidence of TC were obtained from the Belarusian Cancer Registry. Data on 3765 out of 59700 residents of the Stolin district of the Brest region were taken for processing. Of these, there were 1698 males and 2027 women. Of the 40,200 residents of the Luninets district of the Brest region, the cohort included data on 1706 residents, of which 765 were men and 941 were women. Thus, data on 5471 residents (5.5% of the total population) (2463 men and 3008 women), were included in the sample for just two districts out of a total of 99,900 inhabitants. The analysis included only residents of rural settlements who lived in the territory of these areas in April-May 1986. This is due to the assumption of significantly less migration in rural regions. In other words, if these residents were later diagnosed with thyroid cancer, then we can assume that at the time of the Chernobyl accident they were in the same settlements where they were exposed to radioactive iodine as a result of its incorporation. Statistical data processing was carried out using the applied computer programs Statistics 10.0 and SigmaPlot 12.5.

RESULTS AND DISCUSSION

The choice of Stolin and Luninets districts of the Brest region was determined by the fallout of radioactive iodine (I-131), in those territories at the end of April 1986 as a result of the accident at the Chernobyl nuclear power plant. In epidemiological studies, we have taken this period of time as a starting point and have estimated incidence rates since April 1986.

In Figure 1 we show a reconstructed map of the distribution of radioiodine surface activity in soil of Belarus. It is clearly seen that I-131 fallouts took place in the territory of Stolin and Luninets districts and their density ranged from 15 to 100 Ci/km^2.

The analysis of data from the cancer register is surely of great interest in the study of thyroid cancer over the past 30 years, since it contains all verified cases of this pathology. As a comparison group we used data on thyroid cancer cases in the Lepel district of the Vitebsk region. We chose this area due to the absence of deposition of radioactive iodine immediately after the Chernobyl accident, which is clearly seen from the distribution of I-131 surface activity (Figure 1).

Data from the cancer registry for the Stolin district included 149 cases (115 women and 34 men), for the Luninets district it included 86 cases (68 women and 18 men), and for the Lepel district there were 30 cases (23 women and 7 men).

Table 1 shows descriptive statistics for a sample of thyroid cancer cases in Stolin and Luninets districts of the Brest region and the Lepel district of the Vitebsk region for the period from 1986 to 2016.

Obviously, the latency of cancer incidence in both cohorts was approximately the same. The cohorts differed in age at the time of the accident and age at the time of diagnosis. In Lepel district, these indicators in patients were shifted towards older ages, which may be related to the structure of the population. According to the cancer registry, the incidence in rural settlements in two districts of the Brest region was 235 per 100,000 of the population, of which it was 250 in the Stolin district, 214 in the

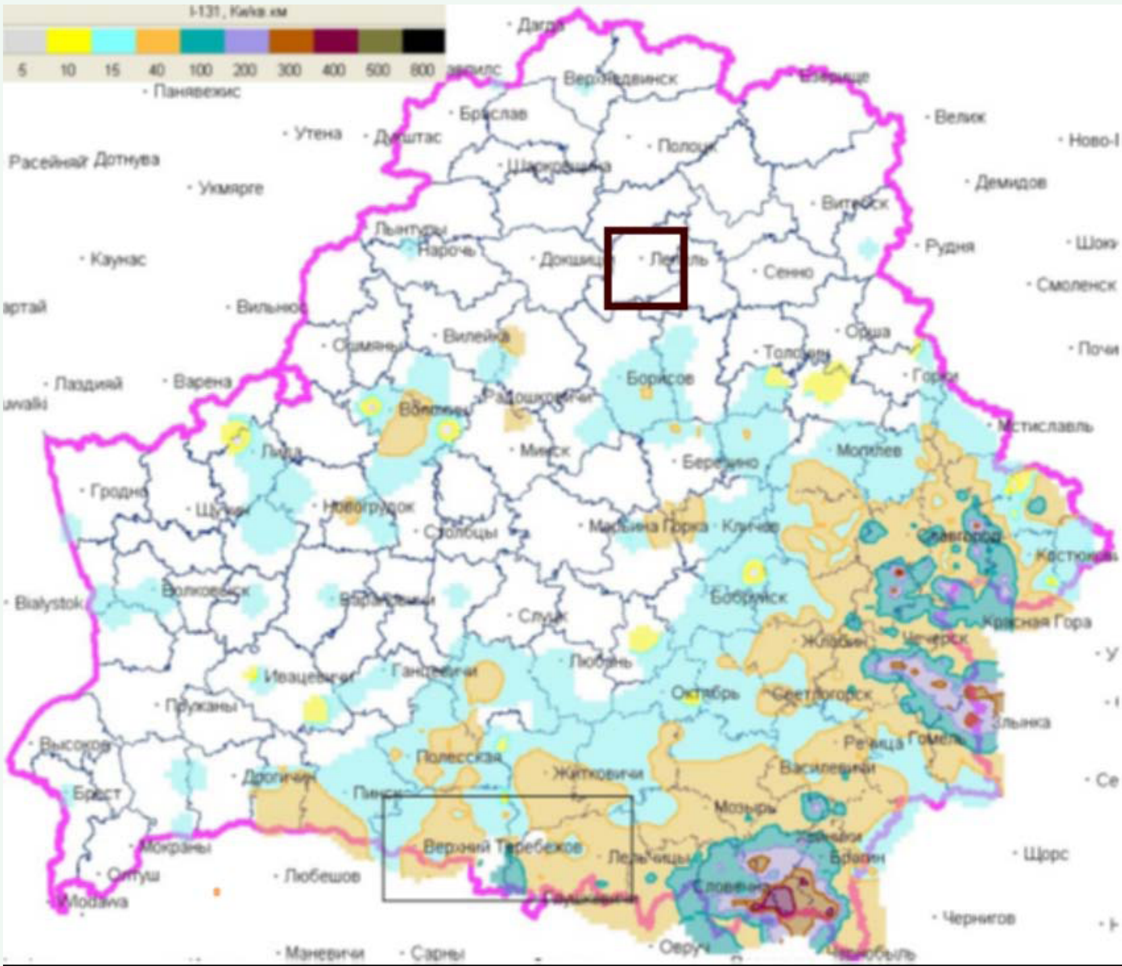

Figure 1 Reconstruction of the distribution of I-131 in soil on the territory of the Republic of Belarus (data as of May 1, 1986) [7]. Note: the frame with thin edges indicates the territory of Stolin and Luninets districts, the frame with thick edges indicates the territory of the Lepel district.

Luninets district; and it was just 83 per 100,000 of the rural population in the Lepel district of the Vitebsk region.

The greatest interest of this study on the incidence of thyroid cancer in Belarus is in the comparison between the regions exposed to radioactive iodine in April 1986 and "clean" regions of our republic. To do this, we compared the main incidence rates in Brest and Vitebsk regions. In Figure 2 there is the diagram with the distribution of the age of patients from the cancer register of Luninets and Stolin districts of the Brest region and the Lepel district of the Vitebsk region. It is obvious that the main group of patients who subsequently had thyroid cancer at the time of the accident were under the age of 1 year. There are two second most frequent groups that include those persons who were 2 and those persons who were 32 years old in April. In contrast to this, in the Lepel district, the main critical factor in the occurrence of thyroid cancer in the aftermath was the age of 18 years as of April 1986. This may be due to the age composition of the inhabitants of these regions. Another reason may be in the increased sensitivity of the child's body to the radiation, in which, as mentioned above, higher absorbed doses should be formed in the thyroid gland. There was no radiation factor in the Lepel region.

The analysis of the distribution of the latent periods of thyroid cancer incidence in the studied regions showed that the first cases of the disease in the affected regions of Belarus began to be recorded immediately after exposure to iodine radionuclides (Figure 3). However, the incidence peaks were registered after the exposure: 13 and 32 years later. In contrast, in the "clean" region of Belarus, in the Vitebsk region, the background incidence rate after 1986 was higher, with one incidence peak clearly distinguished with a latency period of about 17 years.

Another indicator of radiation-dependent thyroid cancer may be the age of patients at the time of diagnosis. Figure 4 shows the diagrams of the age distribution of patients at the time of diagnosis. It is clearly seen that among the inhabitants of the Brest region there is a group of patients who at the time of diagnosis were from 40 to 50 years old. That is, this population group received thyroid irradiation due to the incorporation of I-131 at the age of 10-20 years. In contrast, in non-irradiated persons living in the Vitebsk region, the diagnosis of thyroid cancer has its peak at the age of about 60 years that is much later than in contaminated regions.

It is of interest to analyze the dynamics of thyroid cancer incidence in areas exposed to radiation due to the presence of I-131 immersed in the air, and "clean" regions of the republic. In Figure 5 there are the data of cumulative morbidity for 30 post-Chernobyl years in districts of Brest and Vitebsk regions.

The presented data clearly show the differences in the increase in the incidence of thyroid cancer. In the districts of the Brest region that were contaminated with radioactive iodine, the increase in the incidence is significant ($P < 0.05$), more than 2 times higher than in the uncontaminated region of the Vitebsk region.

Table 1: Descriptive statistics of cases of TC for two districts of Brest region and Lepel district of Vitebsk region from 1986 to 2016.

District	Option	M ± m	Median	R
Stolin and Luninets districts N=235	The age in 1986 (Chernobyl accident), years	22,8±1,1	23,0	
	Latent period, years	18,1±0,6	16	
	The age at the time of diagnosis, years	41,4 ± 1,1	44,0	
Lepel district N=30	The age in 1986 (Chernobyl accident), years	39,1 ± 2,9*	37,5	<0,001
	Latent period, years	17,1 ± 1,5	18	0,583
	The age at the time of diagnosis, years	56,8 ± 2,7*	58,0	<0,001

* denoted statistically significant difference

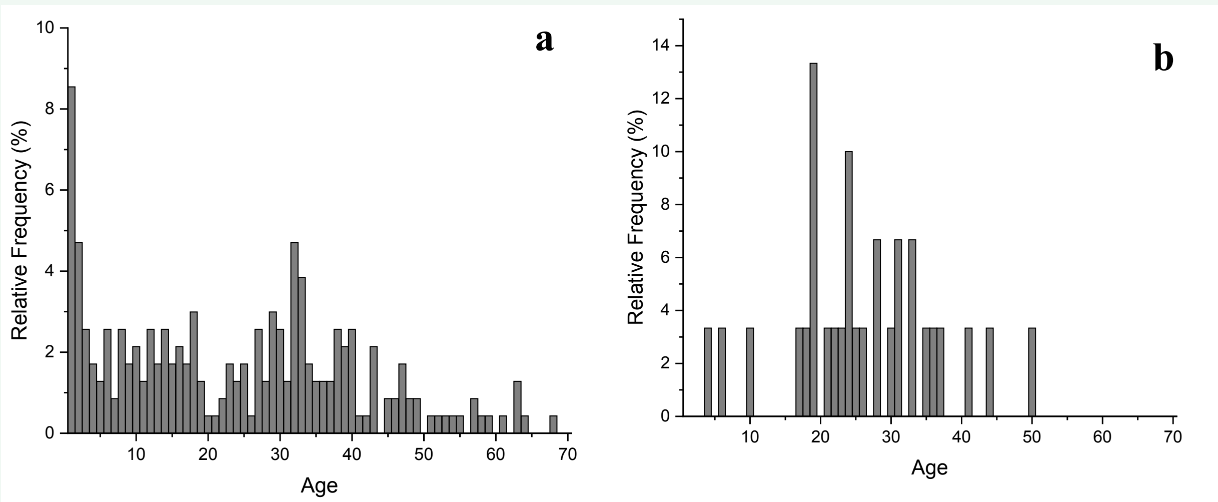

Figure 2 Diagrams of the age of patients with thyroid cancer of both sexes from Luninets and Stolin districts of the Brest region (a) and the Lepel district of the Vitebsk region (b) in April 1986.

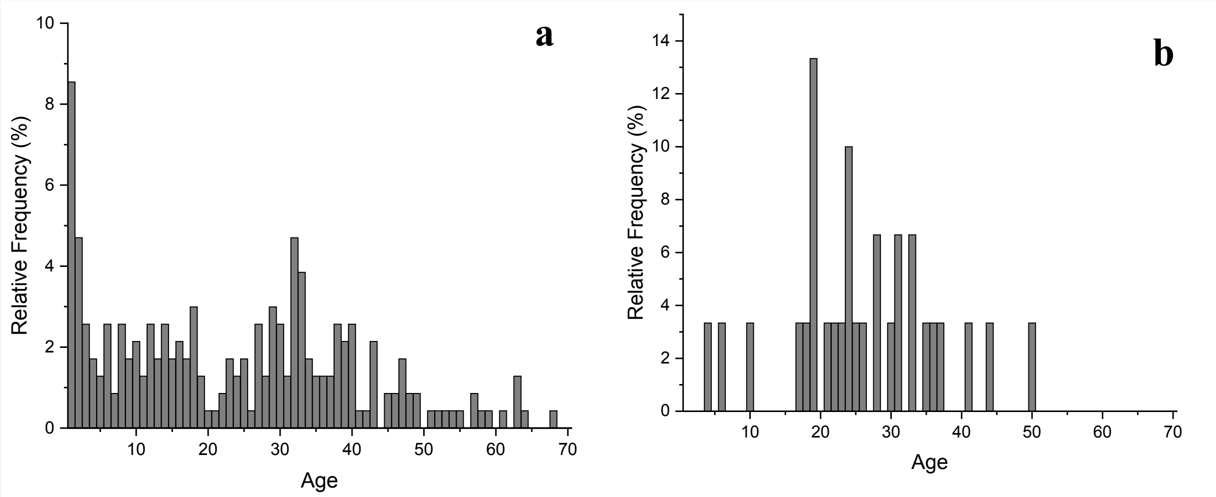

Figure 3 Distribution of latent periods of thyroid cancer incidence of residents of Luninets and Stolin districts of Brest region (a) and Lepel district of Vitebsk region (b).

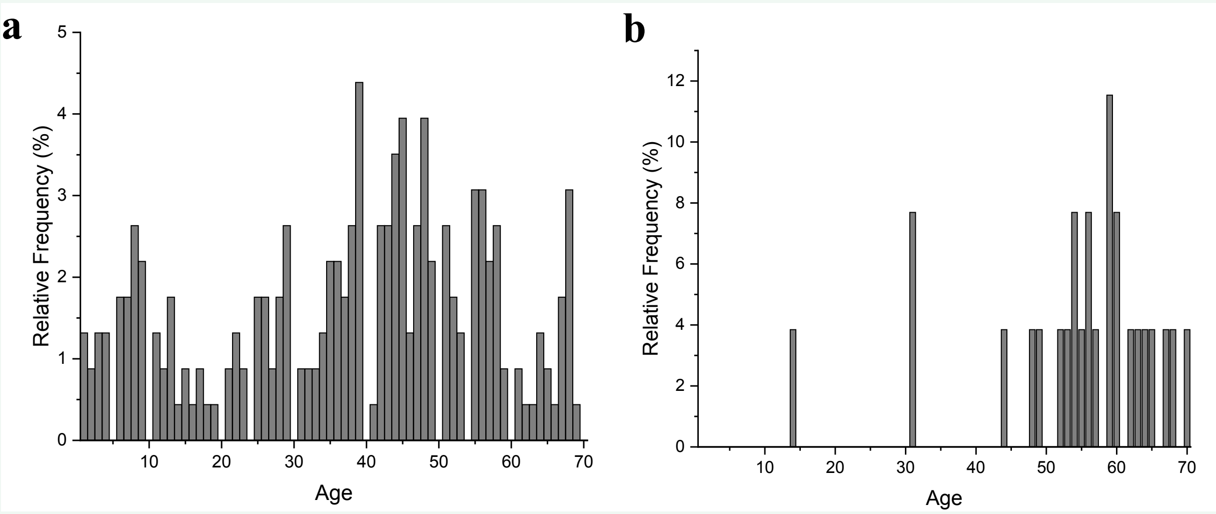

Figure 4 Age of persons of both sexes at the time of diagnosis of thyroid cancer of residents of Luninets and Stolin districts of Brest region (a) and Lepel district of Vitebsk region (b).

It is of interest to study the morphological forms of thyroid cancer in residents of contaminated and relatively clean areas of Belarus. The analysis of the identified stages of thyroid cancer showed that there is just one stage of this oncopathology (T1 form), that has significantly higher incidence in contaminated regions compared to clean ones. The T1 form means a tumor no more than 2 cm in the largest dimension, limited to the thyroid gland (Figure 6).

A significantly greater increase in the registration of thyroid cancer at the T1 stage in the Brest region may be associated with the increased alertness of the health care system regarding the detection of this pathology as a result of medical examination of the population. The system of medical examination of the population in contaminated regions of Belarus has been efficiently functioning since 1993.

CONCLUSION

As stated in the introduction, more than 30 years have passed since the accident at the Chernobyl nuclear power plant. Analyzing the state of health of the population of our republic, one can already draw certain conclusions. First of all, the interest is aroused by the analysis of the incidence of thyroid cancer, since its radiation-induced etiology is well known. In general, the incidence rates of this type of pathology in the Brest region were higher. This can be supported by the significantly pronounced character of the growth of cumulative morbidity in Stolin and Luninets districts of the Brest region. Similar data in the relatively clean area of the Vitebsk region, not affected by the fallout of radioactive iodine from the damaged Chernobyl reactor, were approximately two times lower. The age of the patients with diagnosed thyroid cancer among the residents of

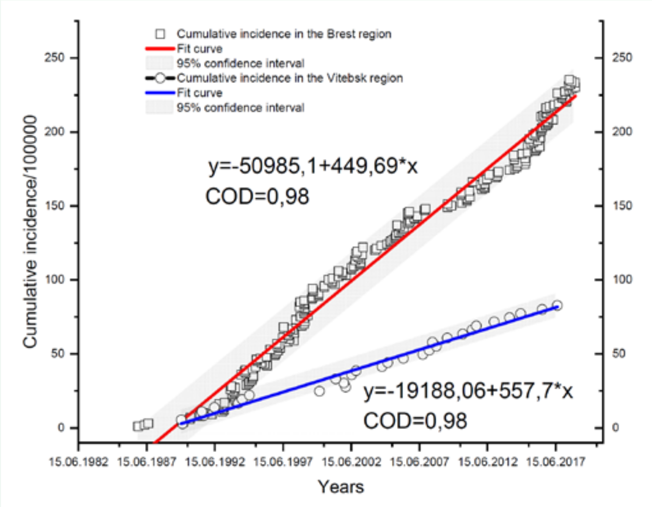

Figure 5 Cumulative incidence of thyroid cancer in two districts of the Brest region and the Lepel district of the Vitebsk region in 1986-2016. COD is the coefficient of determination.

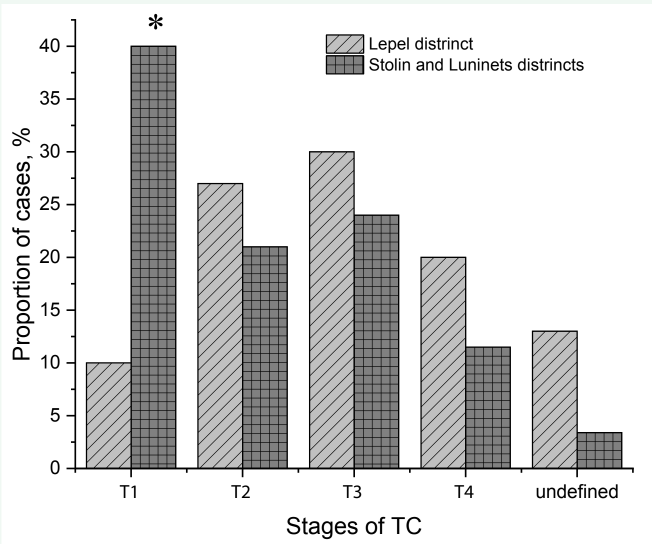

Figure 6 The proportion of cases of thyroid cancer stages in residents of two districts of the Brest region and the Lepel district of the Vitebsk region, identified from 1986 to 2016. * - indicated statistically significant date.

the contaminated areas was significantly younger than among the people living in the Lepel district of the Vitebsk region. There are certain differences in the intensity of the severity of the process. In patients living in the Brest region, the forms of cancer were more often detected at the early stages of the development of the process, although these data may be due to the more frequent and obligatory clinical examination of the population. The data obtained show that further analysis of morbidity should be carried out in comparison with radiation exposure, i.e. taking into account the doses in the thyroid gland in the study cohort.

REFERENCES

1. Chernobyl's Legacy:Health, Environmentaland Socio-Economic ImpactsandRecommendations to the Governments of Belarus, the Russian Federation and Ukraine. The Chernobyl Forum: 2003–2005. IEAE, 2006; 58.
2. Evaluation of data on thyroid cancer in regions affected by the Chernobyl accident: A white paper to guide the Scientific Committee's future programme of work / UNSCEAR (United Nations Scientific Committee on the Effects of Atomic Radiation). – New York. 2018; 30.
3. Weiss W. Chernobyl thyroid cancer:30years of follow – up overview, Radiat Prot Dosimetry. 2018; 1: 58-61.
4. Gavrilin Y, Khrouch V, Shinkarev S, Drozdovitch V, Minenko V, Shemiakina E, et al. Individual thyroid dose estimation for a casecontrol study of Chernobyl-related thyroid cancer among children of Belarus-part I: 131I, short-lived radioiodines (132I, 133I, 135I), and short-lived radiotelluriums (131MTe and 132Te). Health Phys. 2004; 86: 565-585.
5. Drozdovitch V, Minenko V, Khrouch V, Leshcheva S, Gavrilin Y, Khrutchinsky A, et al. Thyroid dose estimates for a cohort of Belarusian children exposed to radiation from the Chernobyl accident. Radiat Res. 2013; 179: 5: 597-609.
6. Astakhova LN, Anspaugh LR, Beebe GW, Bouville A, Drozdovitch VV, Garber V, et al. Chernobyl-related thyroid cancer in children of Belarus: a case-control study. Radiat.Res. 1998; 150: 349-356.
7. Zhukova OM, Germenchuk MG, Podgajskaya MA, Golikov Yu. N, Bakarikova Zh V, Hrushchinskij AA, et al. Rekonstrukciya vypadenij joda-131 posle avarii na Chernobyl'skoj AES na territorii Gomel'skoj i Mogilevskoj oblastej Belarusi, Prirodnye resursy. 2010; 2: 113-120.

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