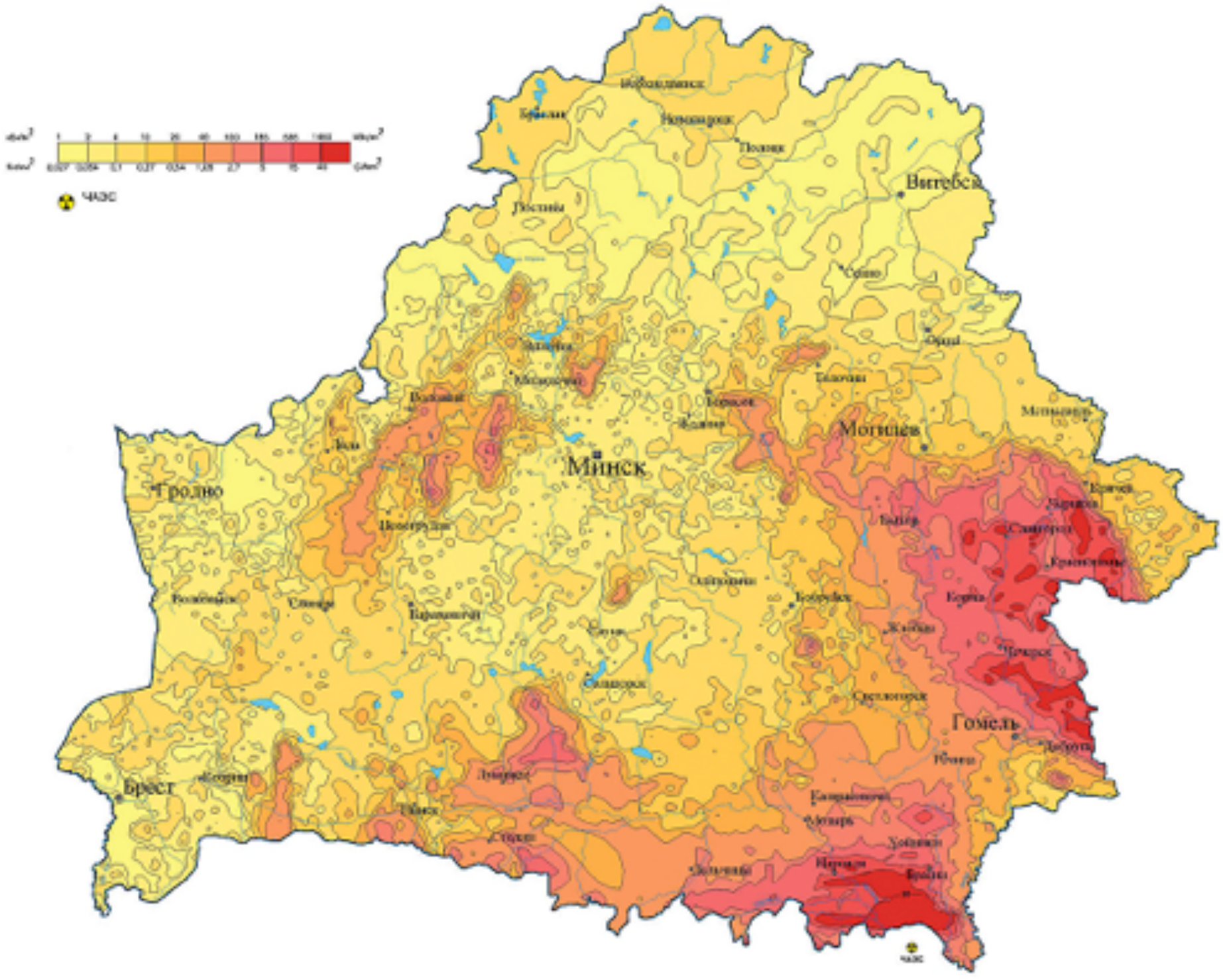
Non-cancerous Medical Conditions in Areas of Belarus Contaminated by Radioactivity from the 1986 Chernobyl Nuclear Accident

Prof. Yury Bandazhevsky
Dr. Galina Bandazhevskaya

Belarus (2009)

Official authorized version

English translation from French by Yuri Hiranuma in 2012

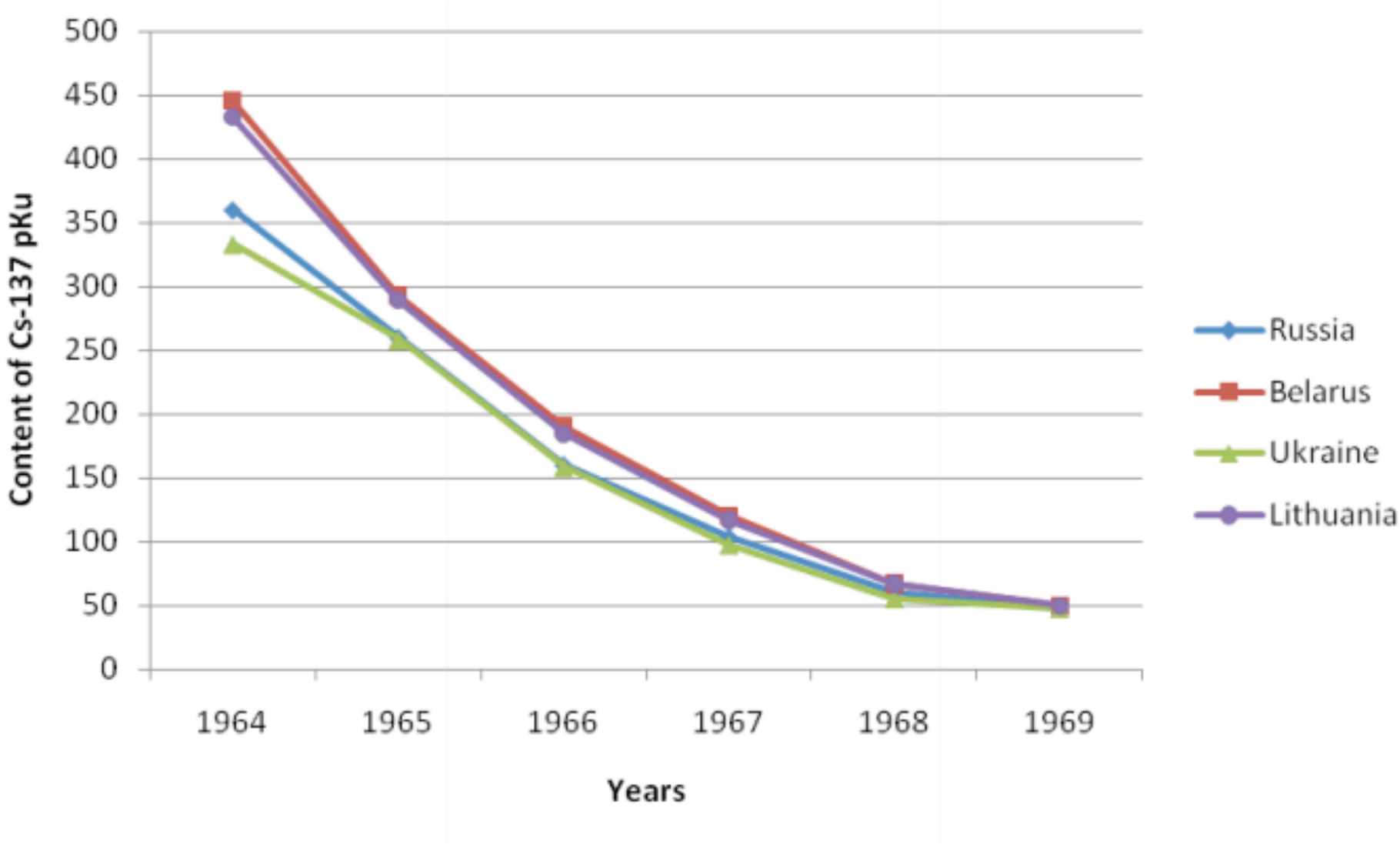


Distribution of Cesium-137 Fallout in Belarus in 1986

Radio-ecological problem

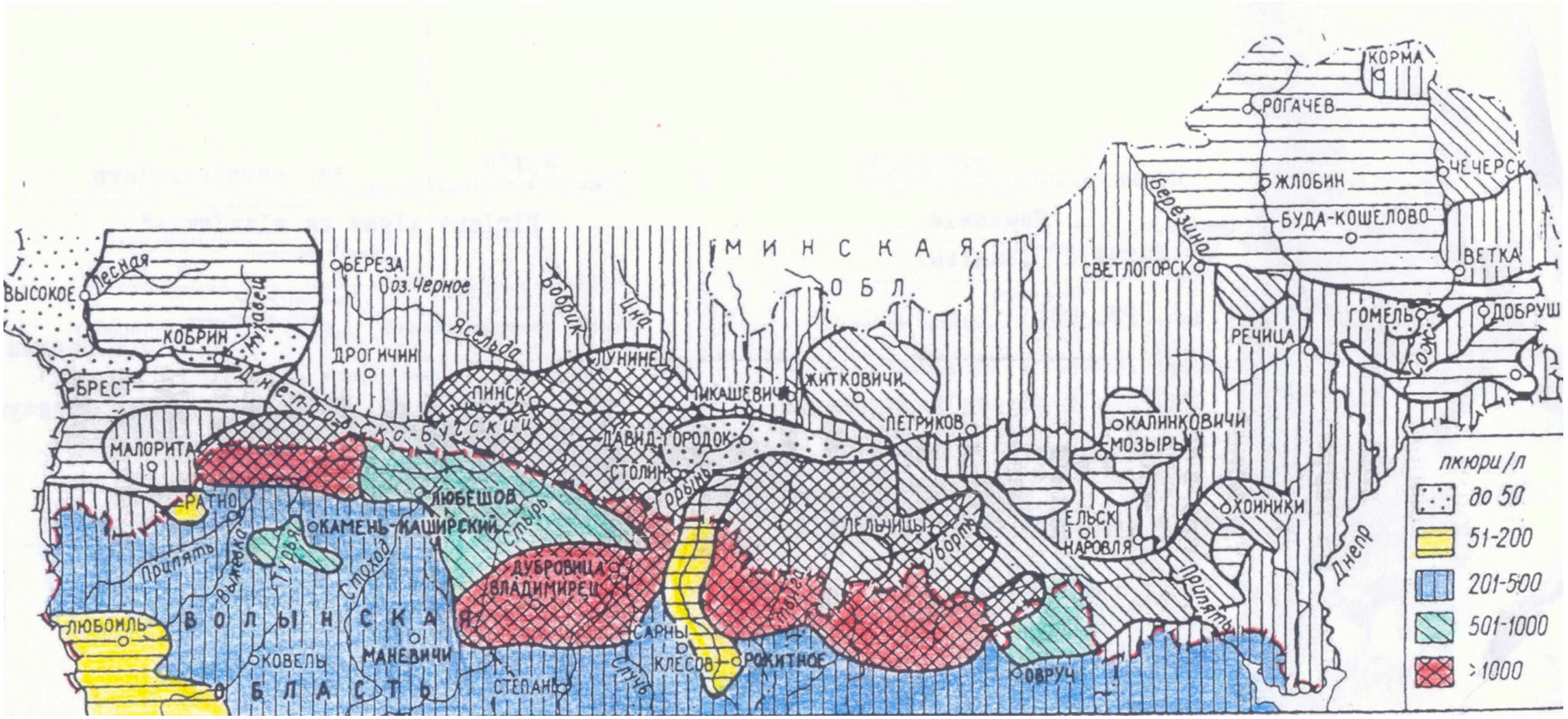
The ecological environment influences health and regulates the development of human society. Not taking into account the considerable progress in protecting the environment and therefore protection of human health, some countries have serious environmental problems. Chief among these countries are those of the former Soviet Union. The aspiration to follow and overtake the military and economic development of the West drove the leaders of the former Soviet Union to implement industrial technology with a fatal impact on the environment and therefore on public health. We must first take into consideration the atomic weapons tests conducted by the USSR.

A consequence of these tests since 1960’s is the pollution by radioactive elements in the huge territories of Belarus, Lithuania, Latvia, Estonia, Ukraine and Russia. The population of these countries had no information on the existence of radioactivity and therefore could not protect itself from its impact in any way.



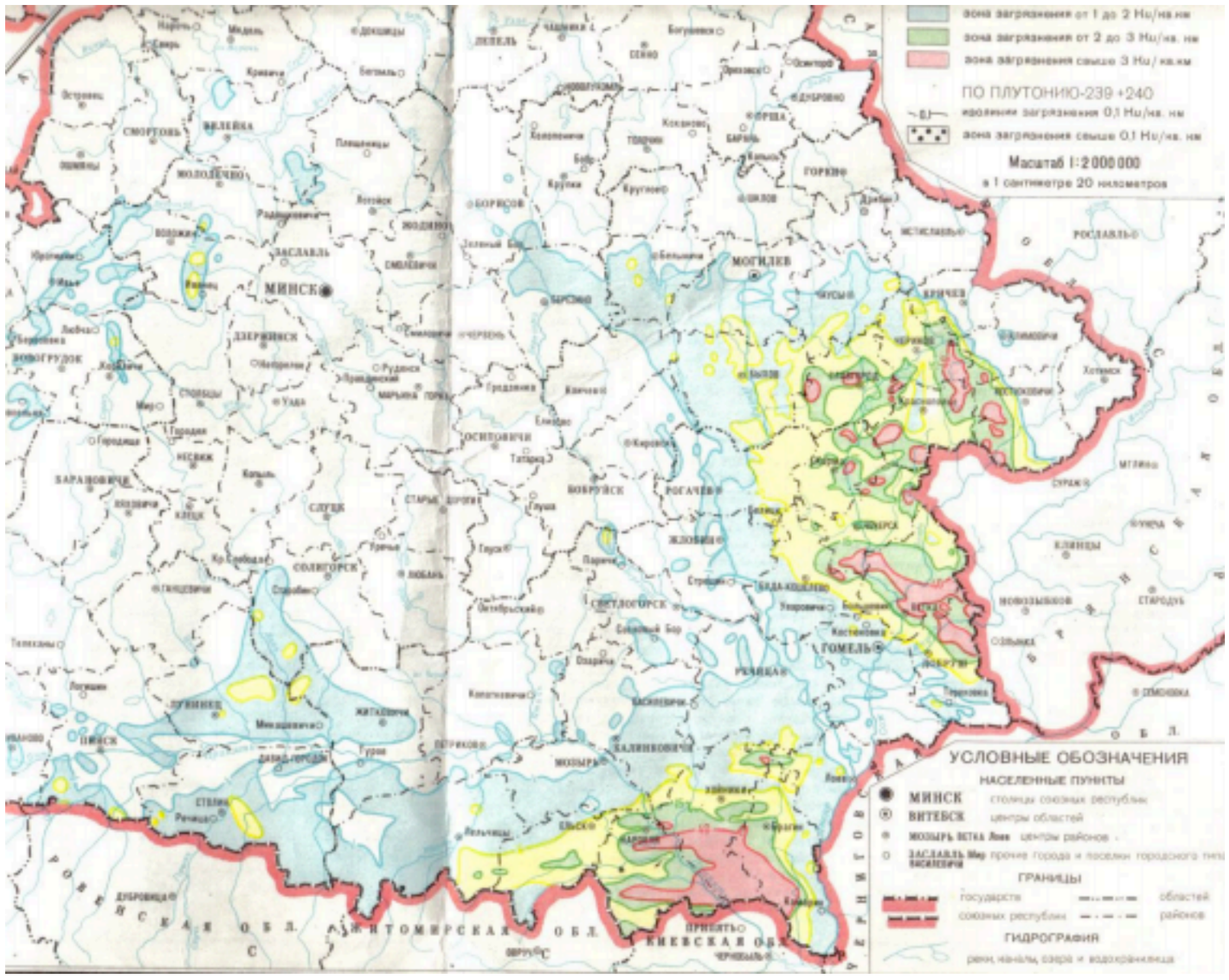
Cs-137 contents in villagers' daily food allowance in pCi. (Marey AN, et al. 1974)

Beginning in the sixties, a large amount of the Cs-137 radionuclides in food were consumed by the inhabitants of the mentioned states for many years. (Marey AN, et al. 1974. Rusyayev AP, et al. 1974. Ternov VI, Gurskaya NV, 1974.)[19]



Cs-137 contents in cow’s milk from different districts of Belarus in the 1960’s.

Cow's milk is a commodity of the inhabitants of Belarus and Baltic countries with rather high levels of the Cs-137 radionuclide. A "milk-cesium Map" was created. The largest quantities of the radionuclide Cs-137 were observed from 1967 to 1970 in the Gomel region of the Republic of Belarus.

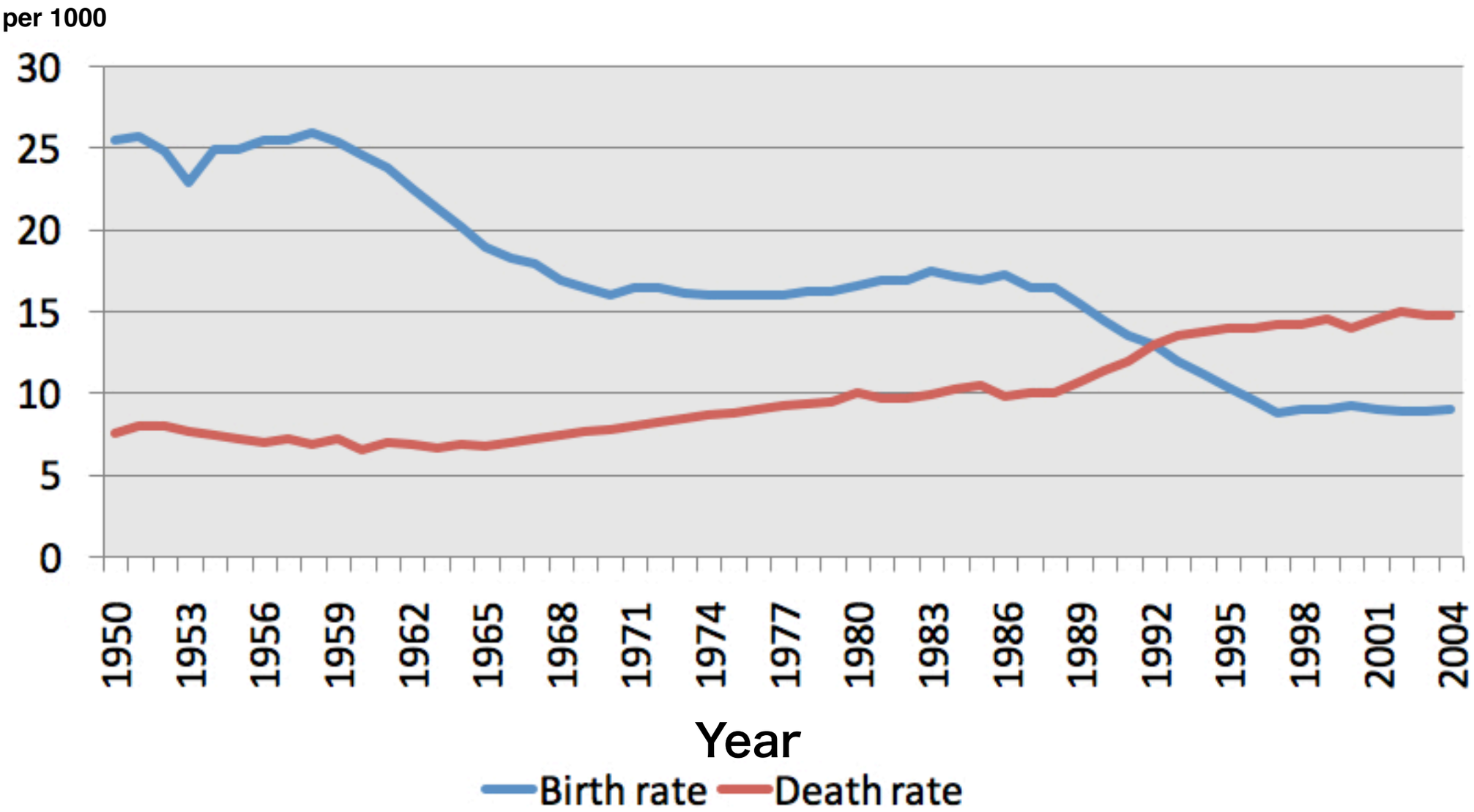


Map of Cs-137 deposition in the territory of Belarus in 1992.

The Chernobyl accident in 1986 has greatly intensified the effects of radioactivity on the existing population of several European countries and primarily that of the Republic of Belarus. The 1992 map of the deposits of Cs-137 in the territory of Belarus after the Chernobyl accident almost corresponds to the 1974 map of Cs-137 deposits in the territory of Belarus in the 1960s. (Marey AN, et al. 1974.)[19]

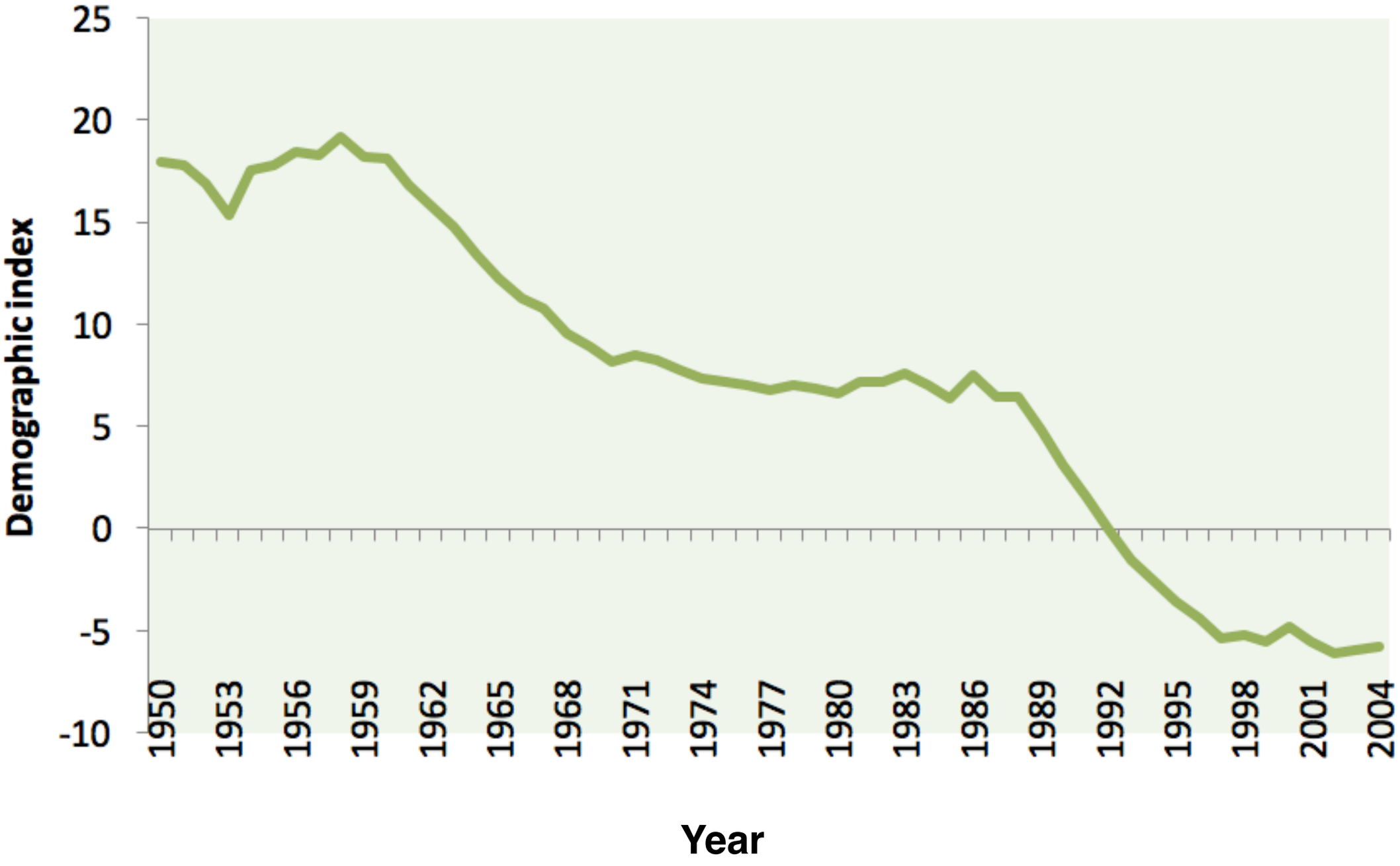
Just after the Chernobyl accident of 1986, thanks to measures implemented by Western public organizations, it became possible to speak of the influence of radioactive agents on human health in Belarus and other countries.

The Chernobyl disaster is considered the largest man-made disasters in terms of the magnitude of its consequences. Its social, medical and ecological consequences require a further detailed study. Of all European countries, Belarus was the most affected. About 70% of radioactive substances released into the atmosphere during the accident from the fourth reactor of the Chernobyl nuclear power plant have contaminated 23% of the territory of the Republic. Currently, approximately 1.4 million inhabitants, including 260,000 children, live in the area. Radioactivity could still impact several affected areas with a difficult situation. And the main danger to health comes from radionuclides Cs-137 and Sr-90 entering the body through food. The contribution of these two radionuclides to internal doses reaches 70 to 80% (National report: Twenty years after the Chernobyl accident). Exposure to radioactive agents has led to a doubling of mortality rates over the past 20 years. During the period 1990-1999 alone, the mortality rate increased by 32.7% (from 10. 7 to 14.2 per thousand); 40.2% in men and 24.3% in women.[21]This trend in mortality is especially pronounced in districts experiencing high levels of contamination by Cs-137 and Sr-90.

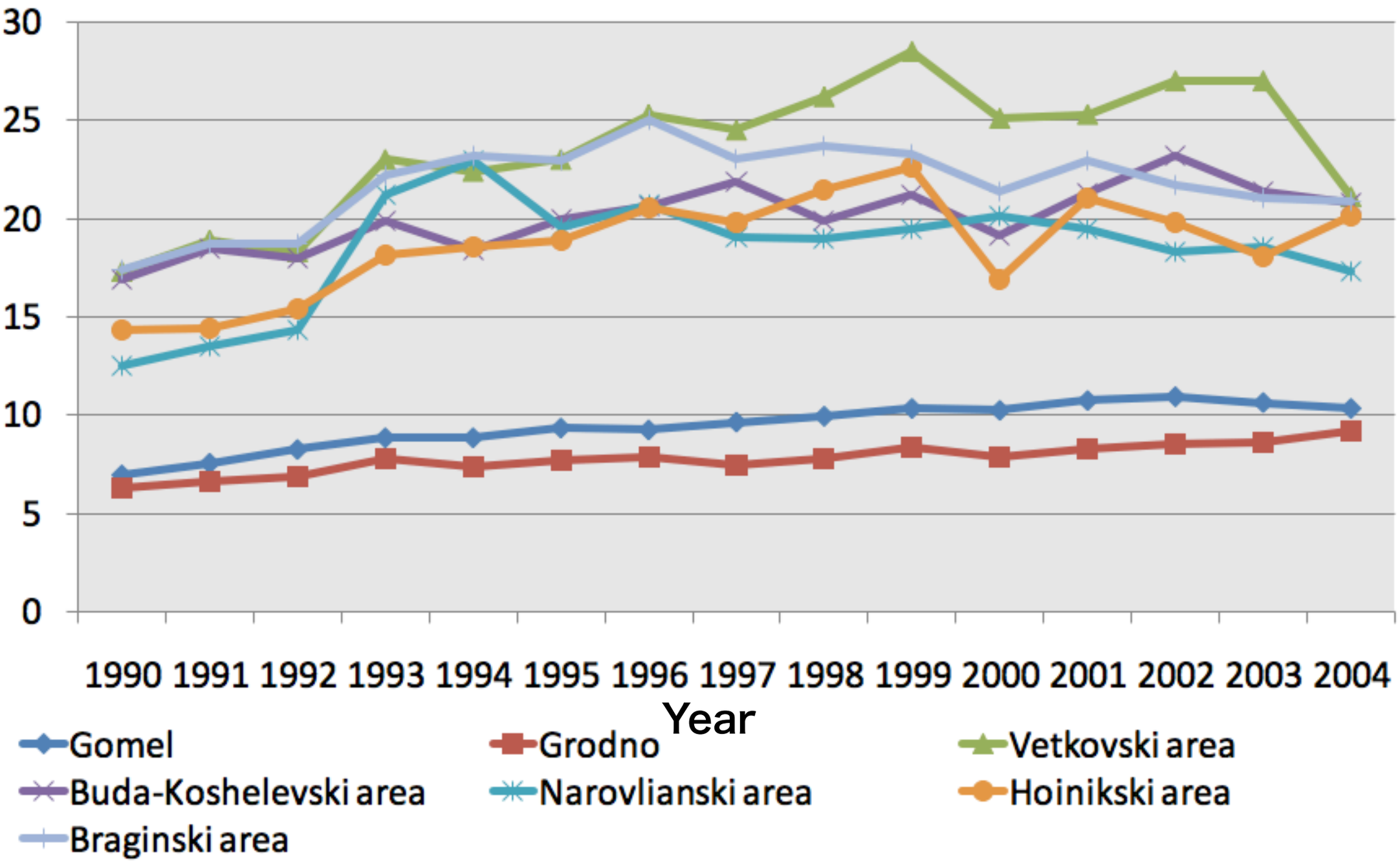


Indices of the death-rate and the birth-rate (per 1000 inhabitants) in the Republic of Belarus.

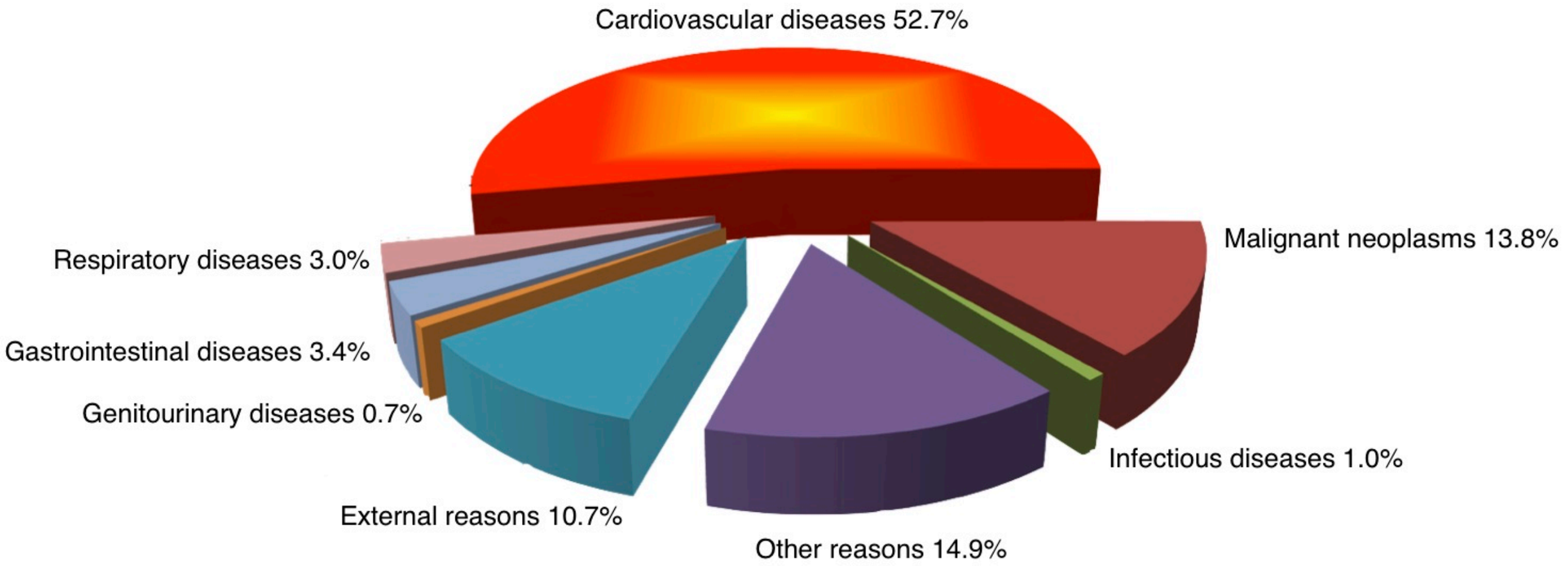
Increased mortality rate and declining birth rate in Belarus since 1993 are reflected by a negative indicator of population growth (population index) : -5.94 in 2002, -5.54 in 2003, and -5.24 in 2005. We can say this is not a growth indicator but an indicator of population decline.



Population index of the Republic of Belarus

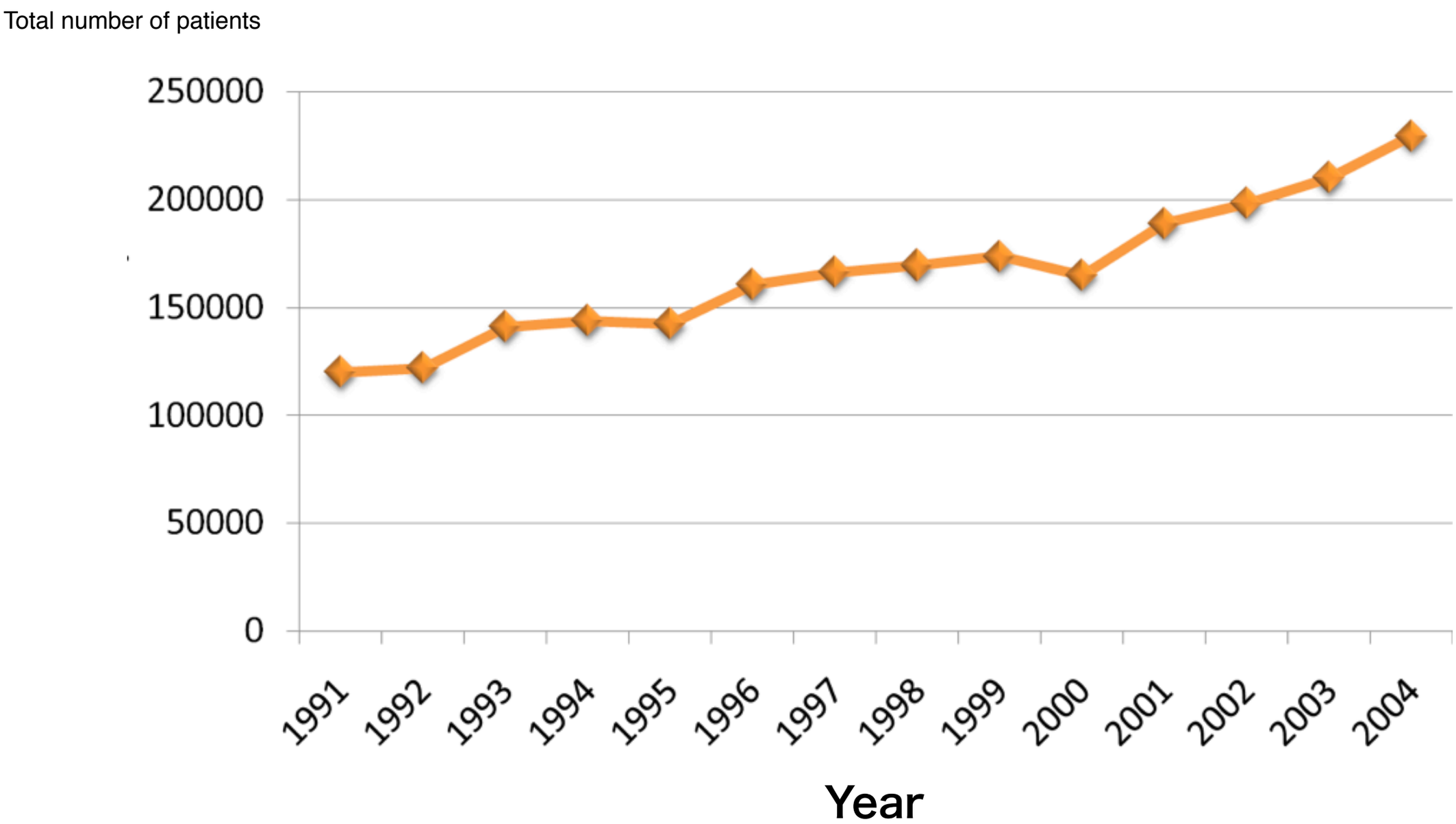


Trends in death rates in different regions of Belarus



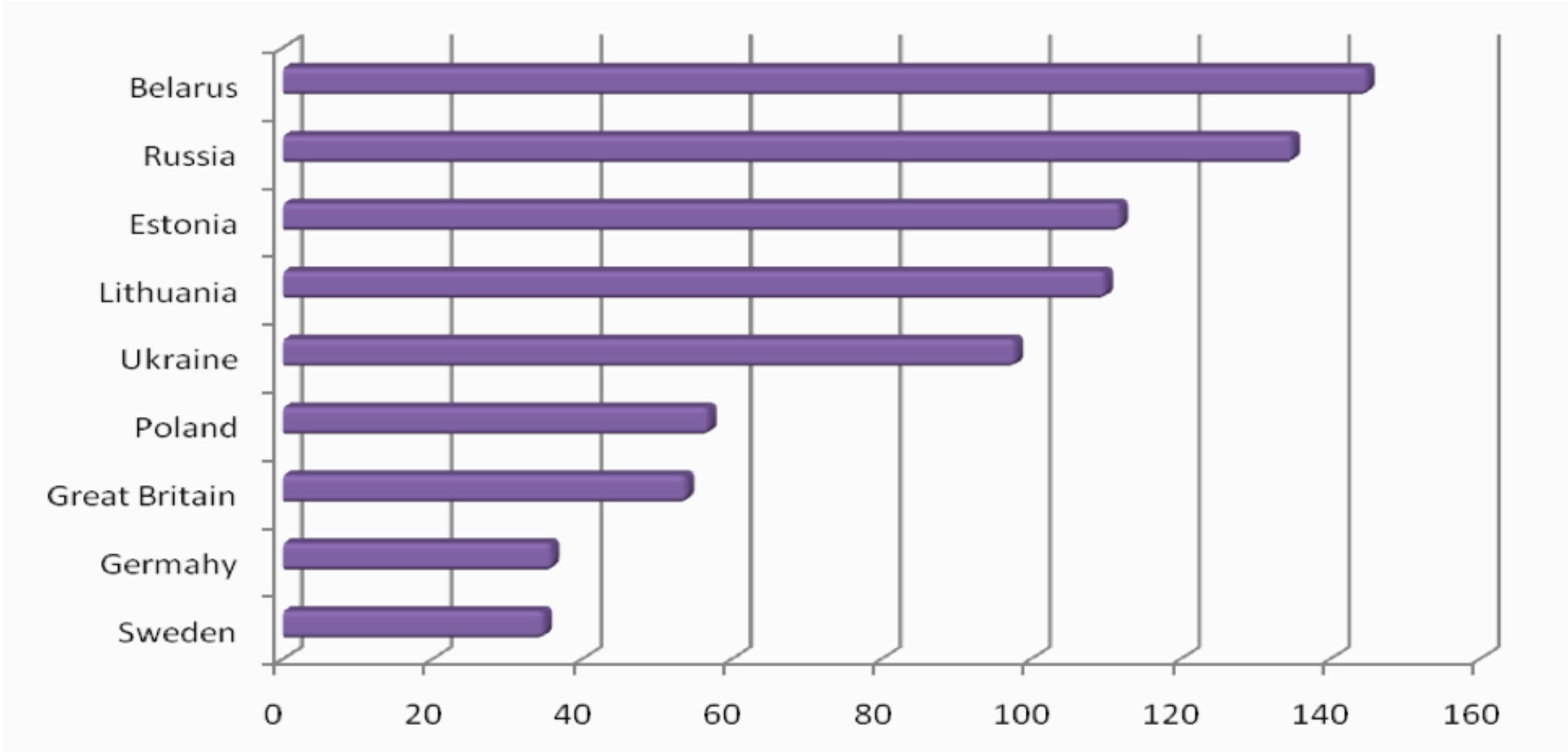
Breakdown for the causes of death in Belarus in 2008.

Among the causes of death of the inhabitants of Belarus, cardiovascular and oncologic diseases take a dominant place.



The dynamics of cardiovascular diseases in the Republic of Belarus.

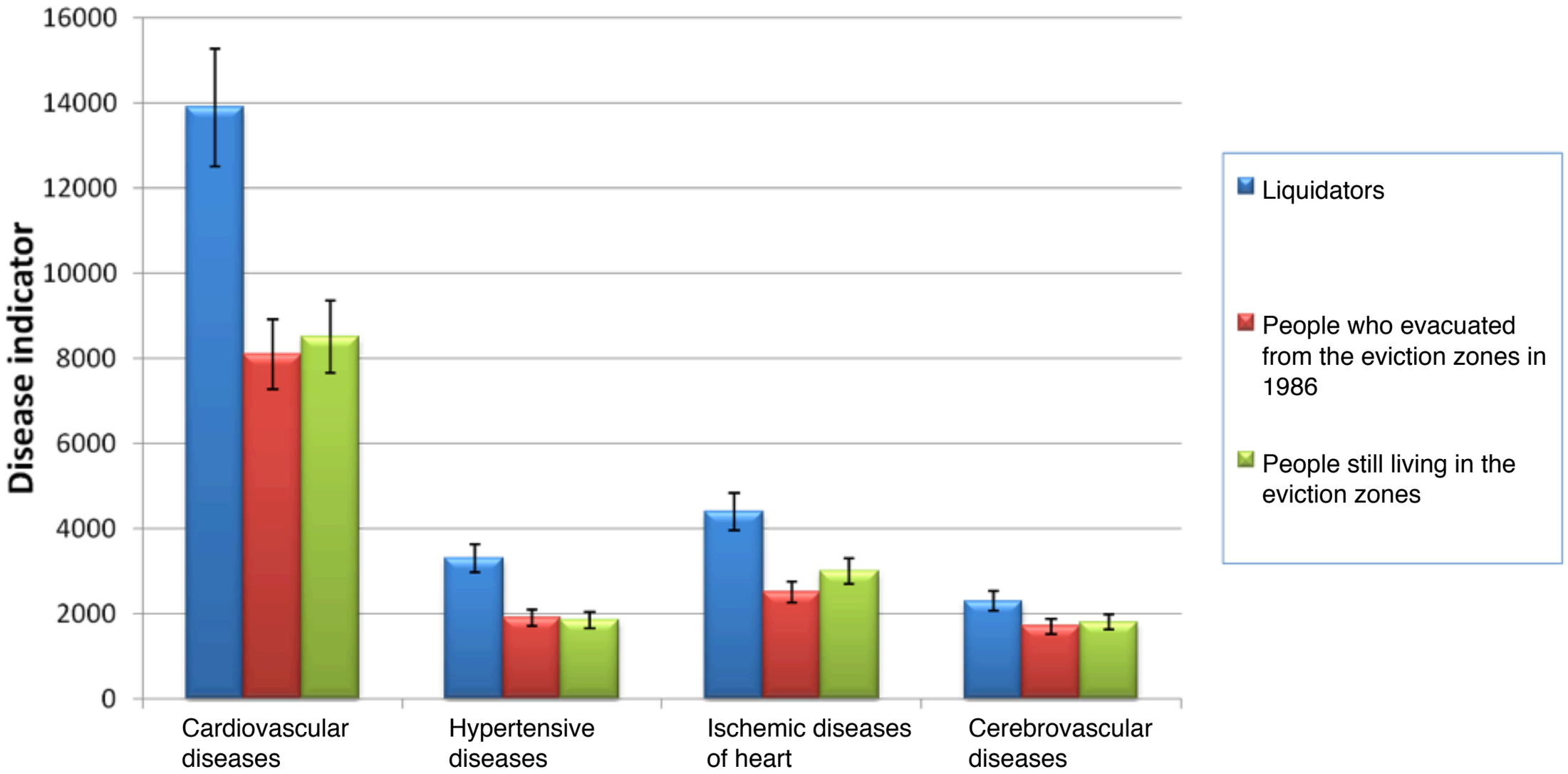
One cause for concern is the significant increase in the incidence of the cardiovascular diseases, especially among liquidators of the Chernobyl plant.



Ischemic heart disease rates in Europe per 100,000 inhabitants in 1993-1994.

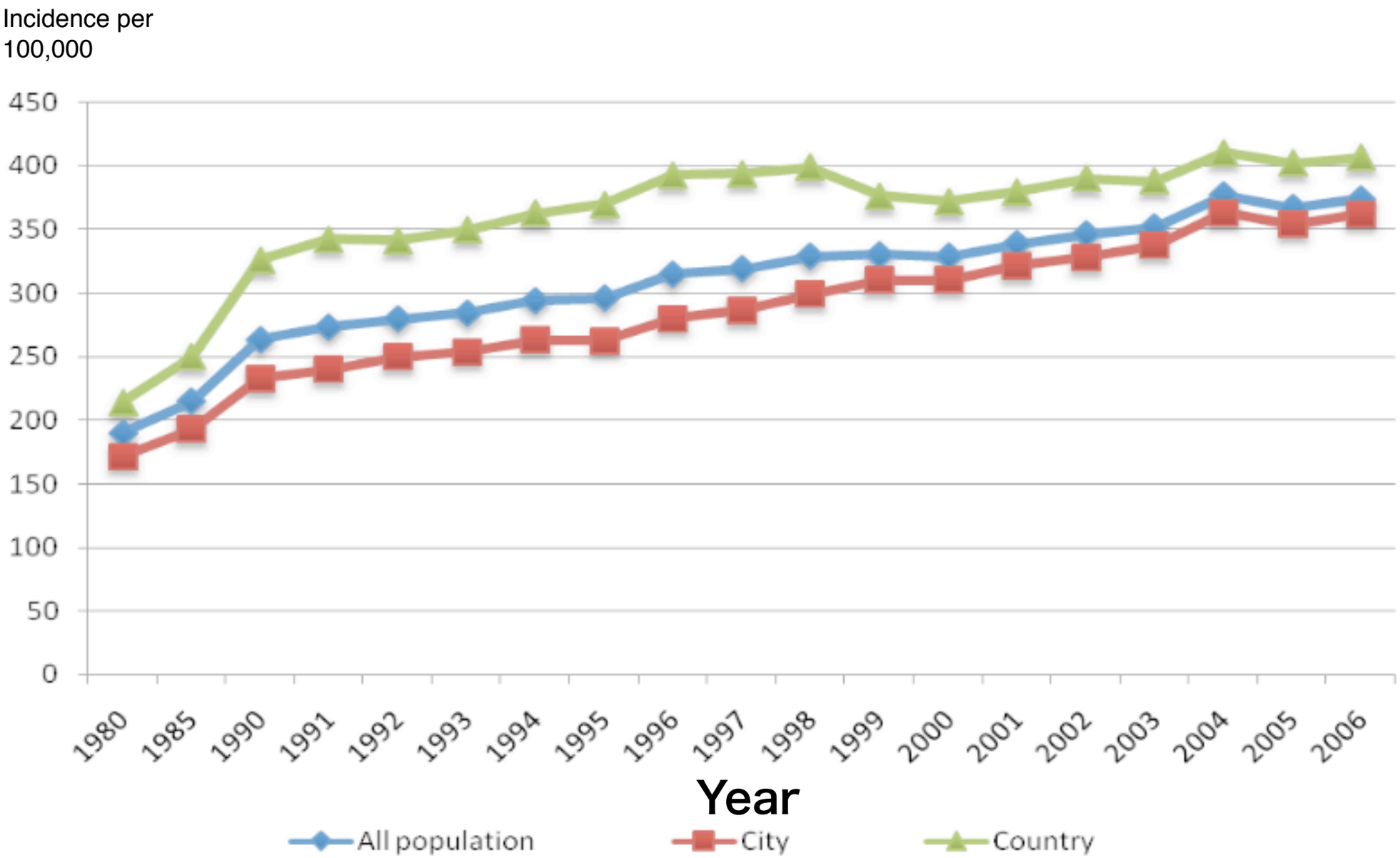
The indices of morbidity in the countries of the former USSR are significantly worse than those of Western countries.

≪The population health in Europe. Report on monitoring measures to obtain health for everyone in 1993-1994. Regional WHO publications, European edition, 556, Copenhagen, 1995.≫[11]



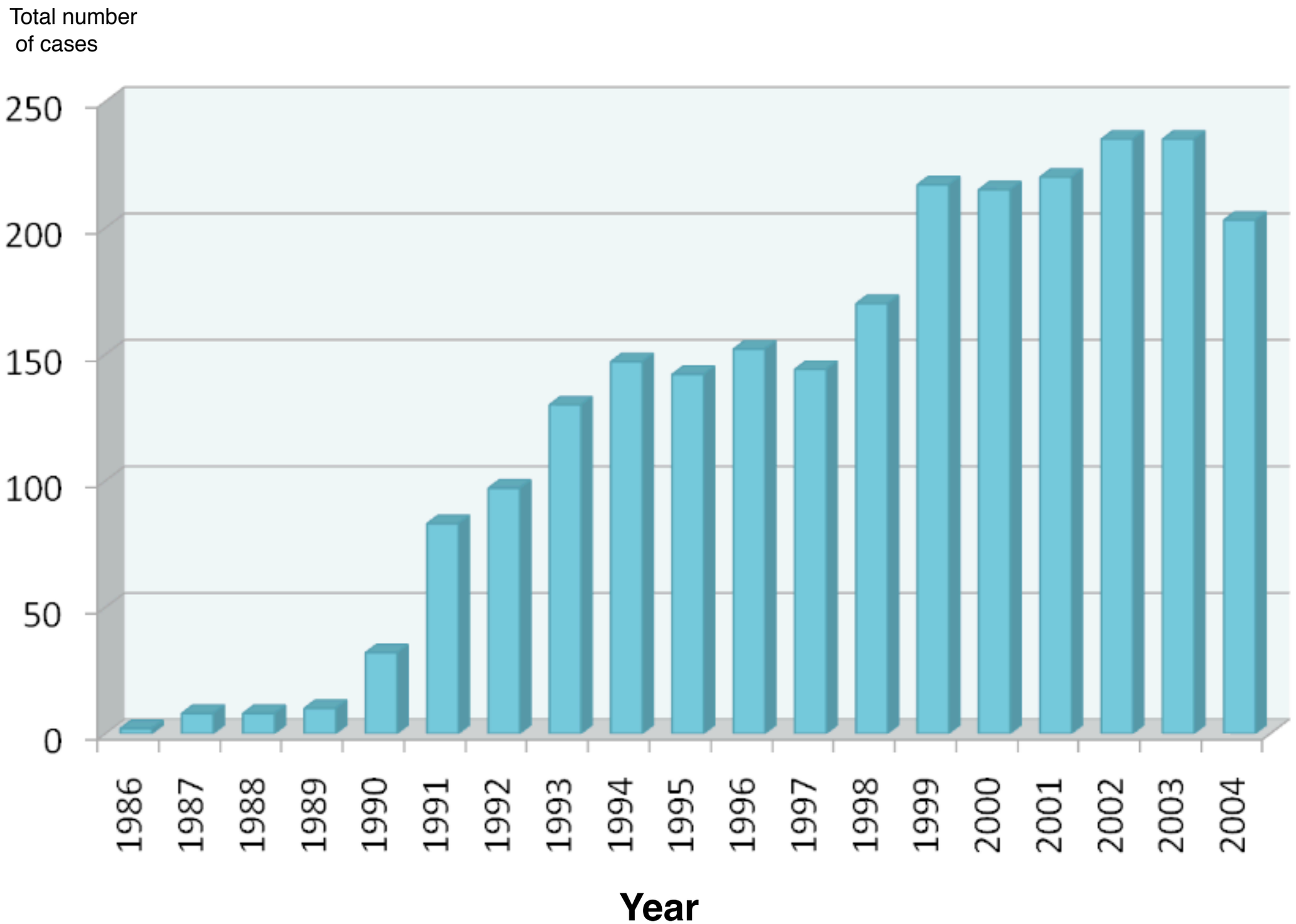
Standardized incidence of vascular diseases in men affected by the consequences of the Chernobyl disaster.

It is particularly important to take into account, in liquidators, this significant increase in vascular diseases, namely hypertension, myocardial ischemia (including myocardial infarction) and cerebrovascular accidents, especially in comparison with other male categories in Belarus.

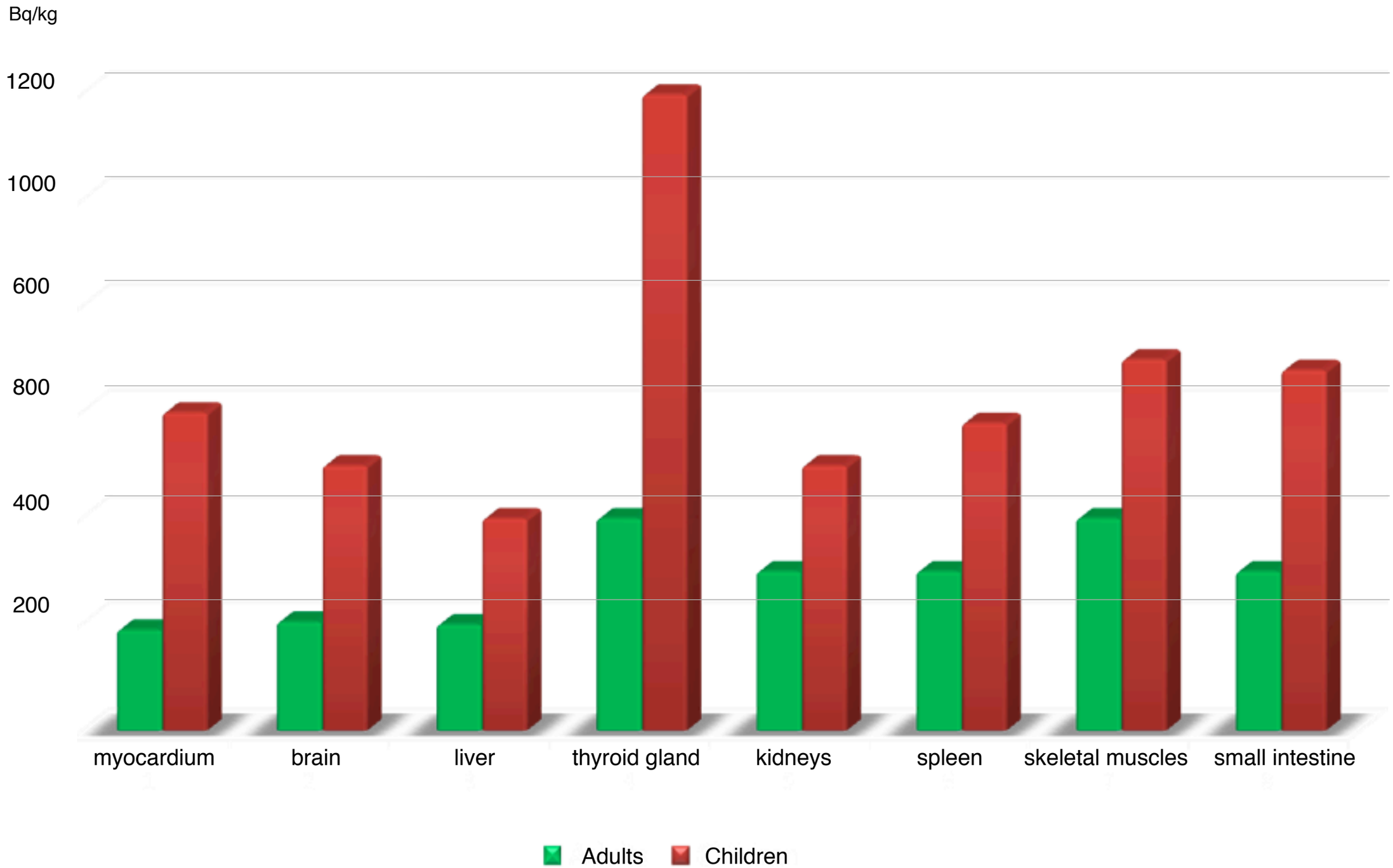


Incidence of malignant tumors per 100,000 in the population of the Republic of Belarus.

In the 20 years since the Chernobyl accident, the incidence of malignant tumors has been increasing in the Republic of Belarus.

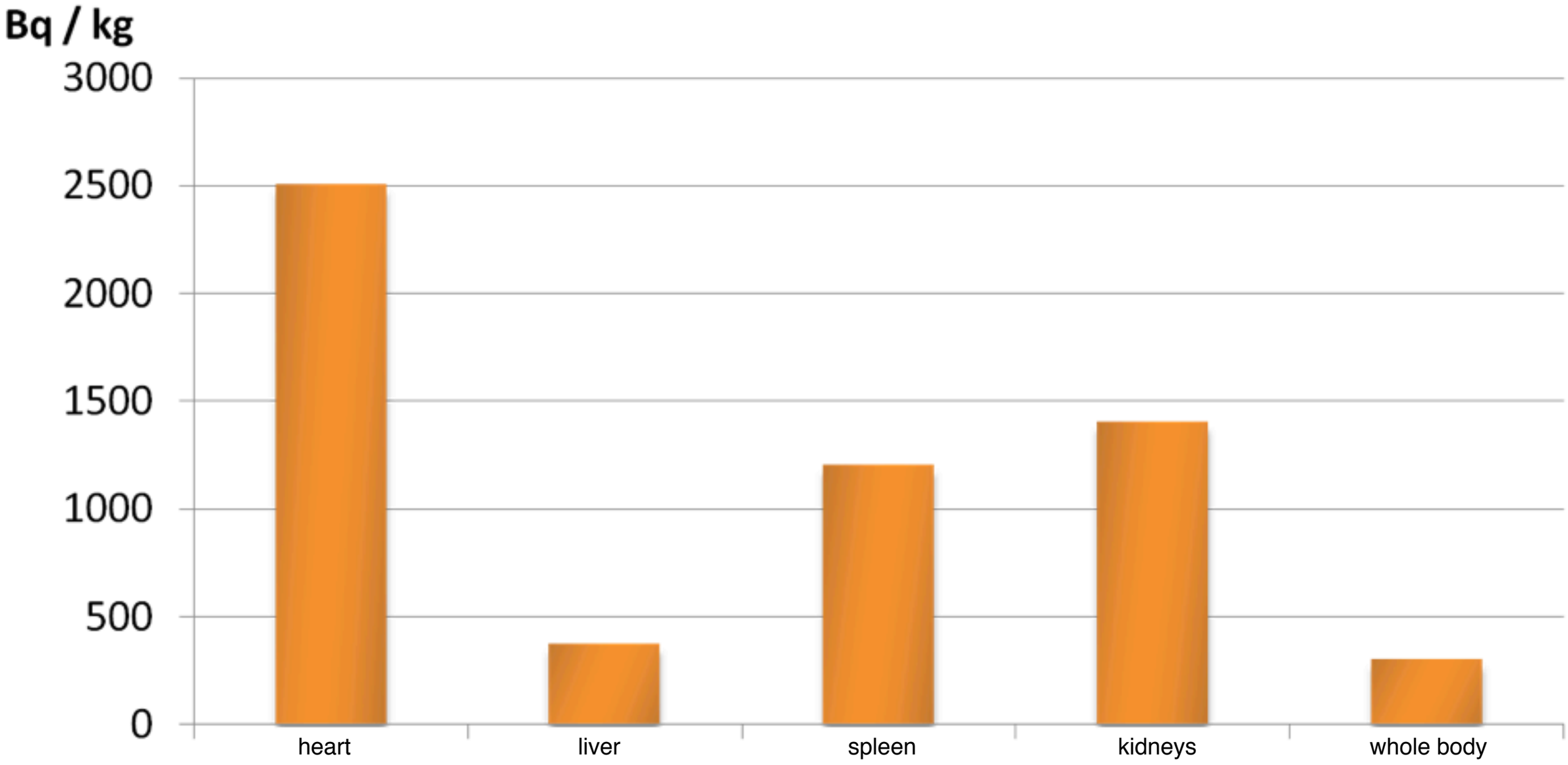


Changes in the number of new cases of thyroid cancer.



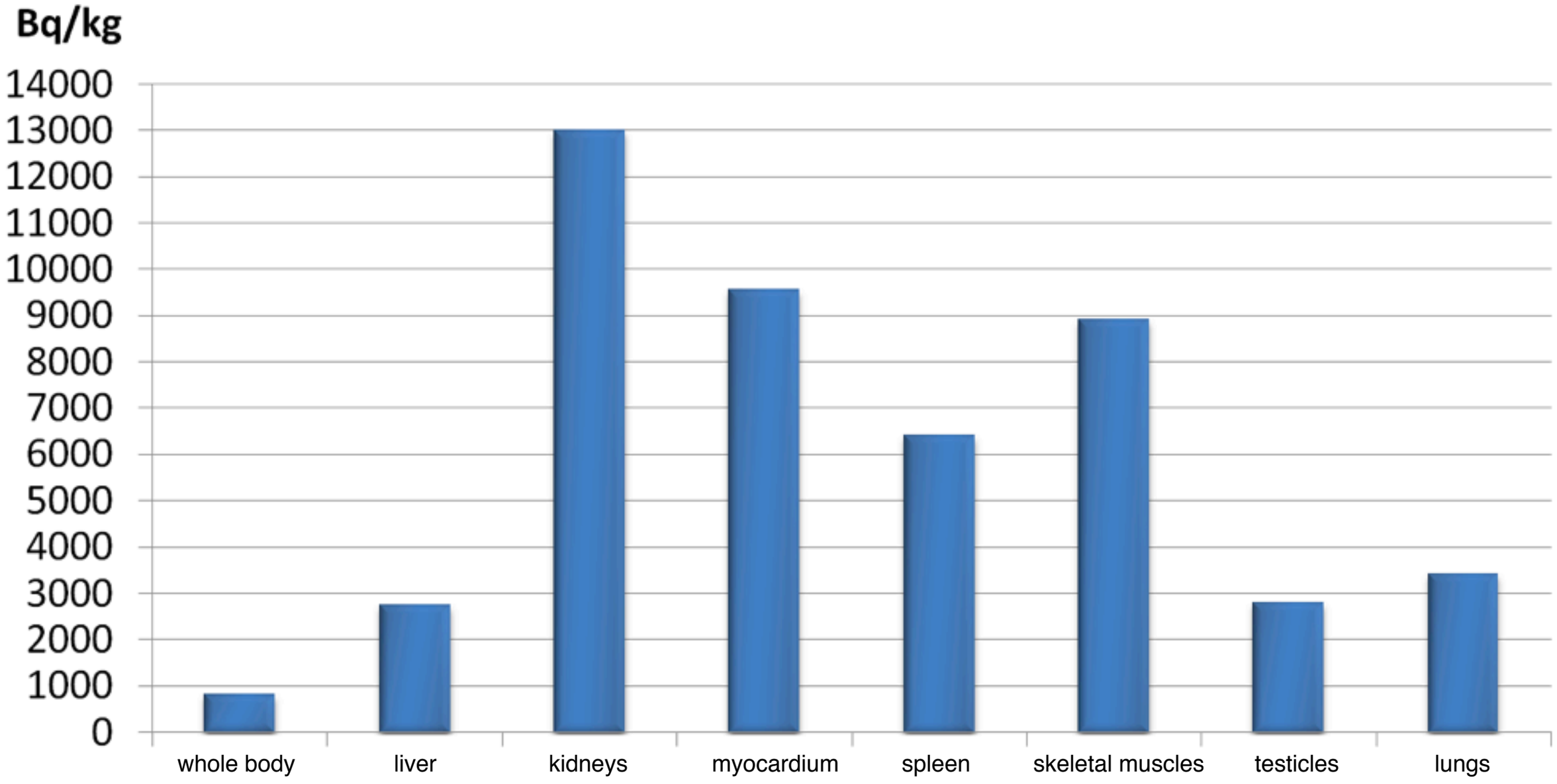
Accumulation of Cs-137 in the viscera of adults and children in the Gomel region measured by radiometry at autopsies in 1997 and 1998. (Bandazhevsky, YI, 1999, 2003.)

Due to chronic ingestion through food, Cs-137 accumulates in several organs in various concentrations: thyroid, heart, kidneys, spleen, liver and brain.



Cs-137 accumulation in organs and the body of experimental animals

This is drawn from the animal experiments during the incorporation of relatively low doses of the radionuclide.



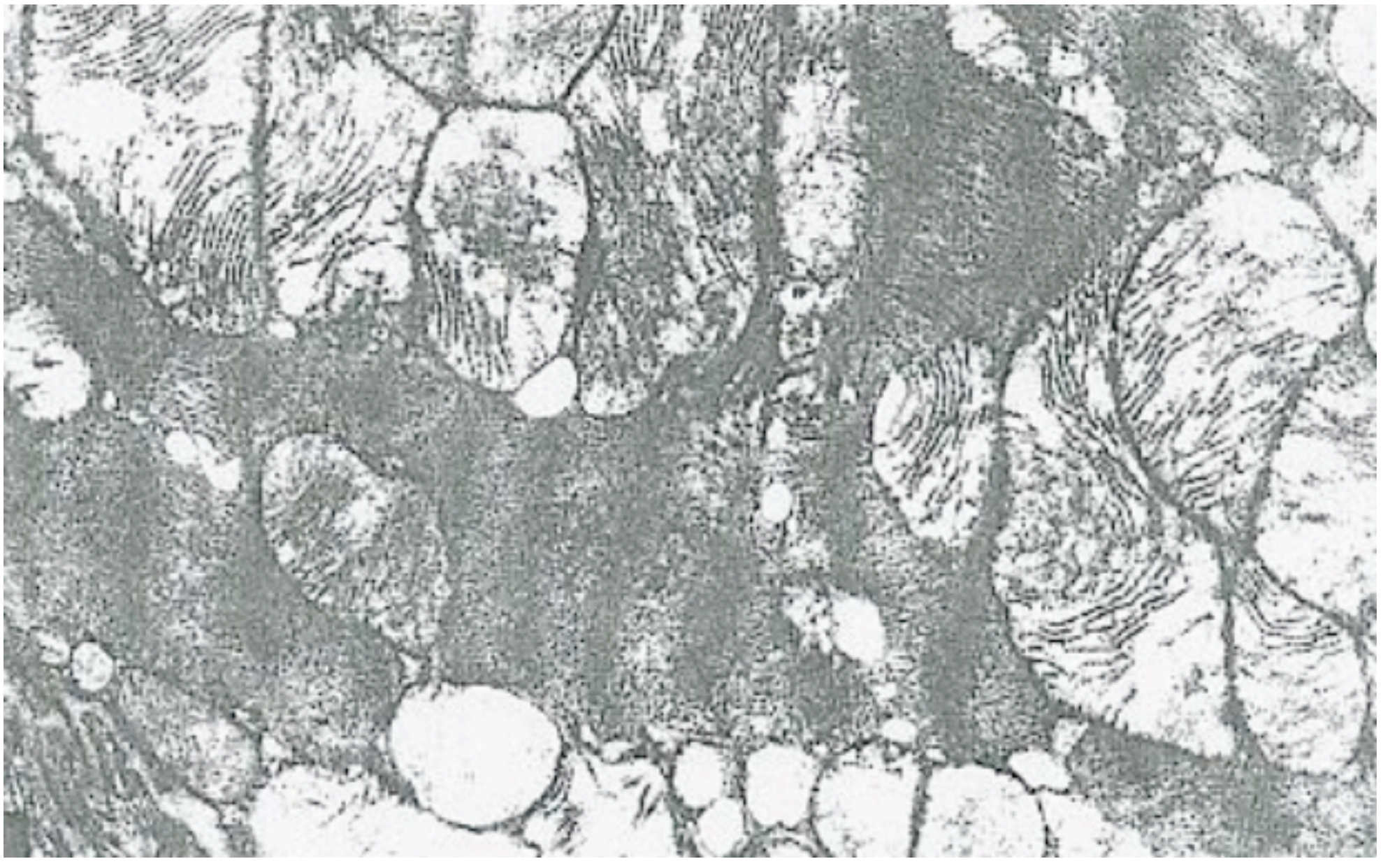
Accumulation of Cs-137 in the internal organs of albino rats at a daily intake of 180 Bq

Increasing doses of Cs-137 into the body through the digestive tract causes its accumulation in other organs, particularly skeletal muscles.

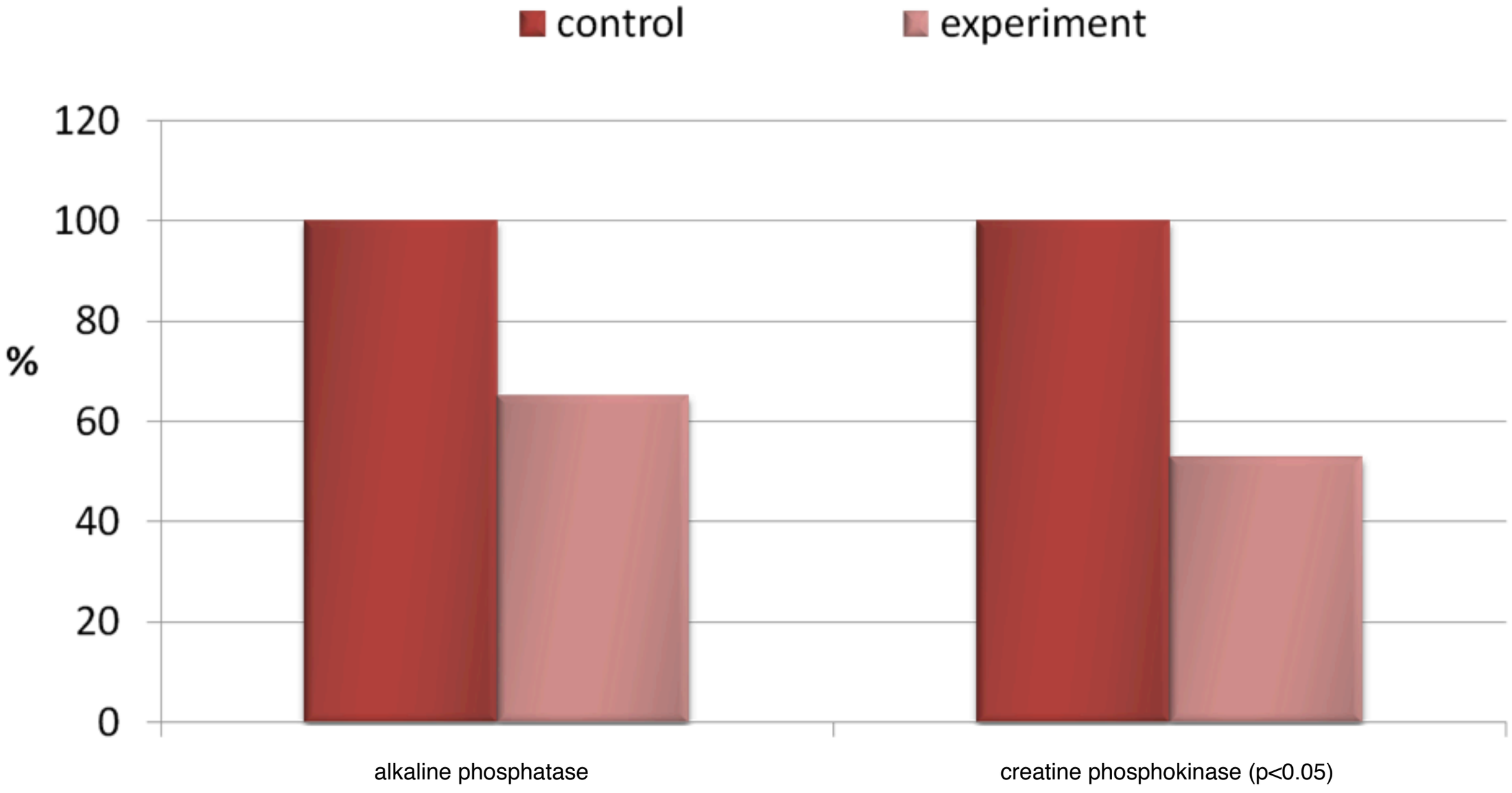
The incorporation of Cs-137 leads to the energetic and metabolic disorders in highly differentiated cells and also results in dystrophic and necrobiotic processes. The degree of the disorders is a function of the Cs-137 concentration in the body and the organs mentioned previously. The higher the concentration, the greater the disorders.

As a rule, several organs are subject to the radiotoxic effects simultaneously, provoking metabolic dysfunctions. It should be noted that organs and tissues under physiological conditions with little or no cell replication (such as the myocardium) are the ones which are the most affected. The Cs-137 accumulates in the body, disrupting metabolic processes and affecting the structure of cell membranes.

The consequence of this process is the structural and functional disorders of many vital systems, primarily the cardiovascular system. Toxic effects of progressive accumulation of radioactive cesium result in structural, metabolic and functional changes in the myocardium, disrupting the energy system and mitochondria. Profound and irreversible changes in the organelles (related to the increased concentration of Cs-137) lead to intracellular necrobiotic processes. Suppression of creatine phosphokinase appears as a consequence of the energetic instability.

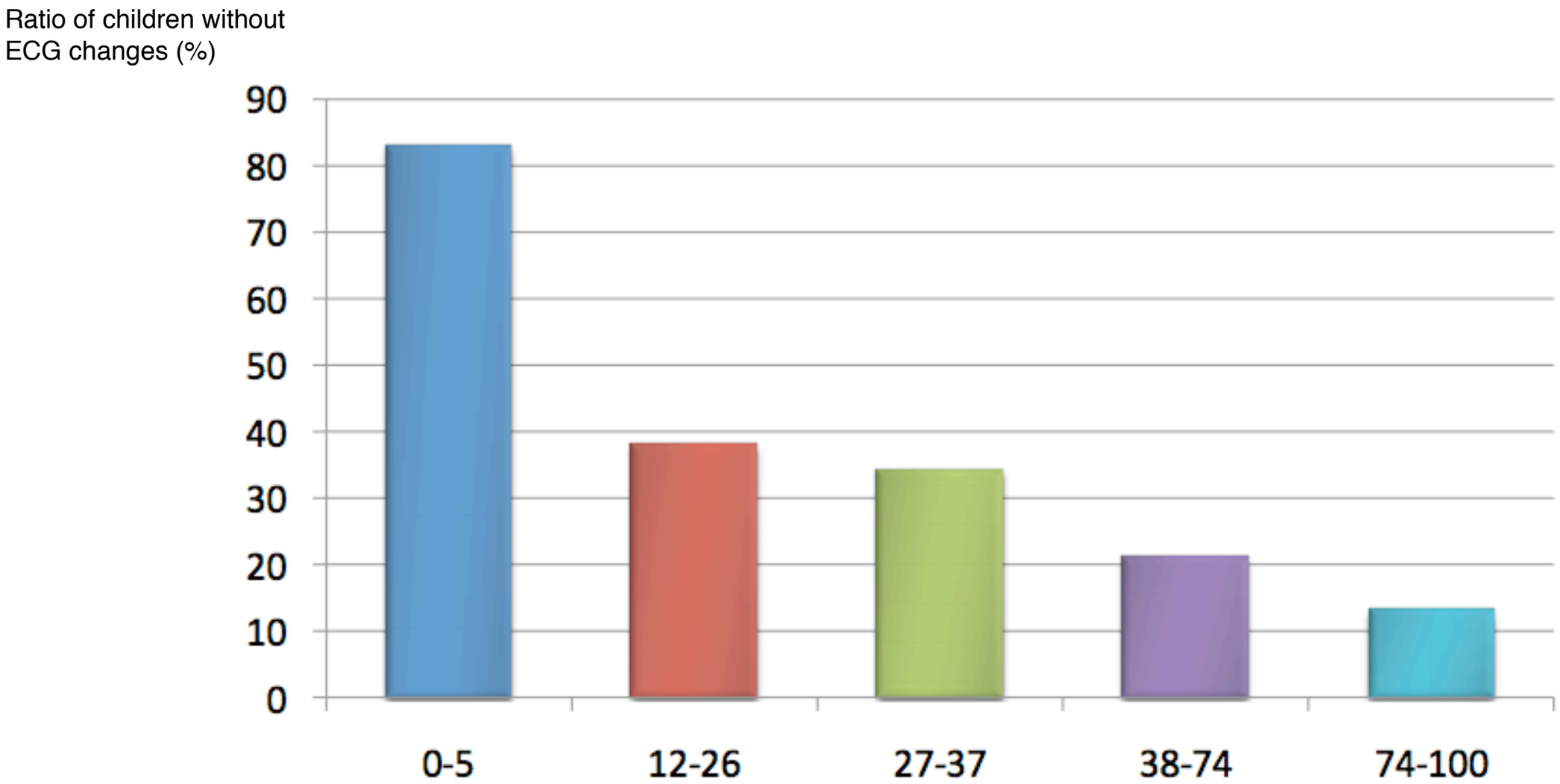


Accumulation of radioactive cesium at 45 Bq/Kg in the mitochondria of rat myocardial cells. Magnification x30,000.

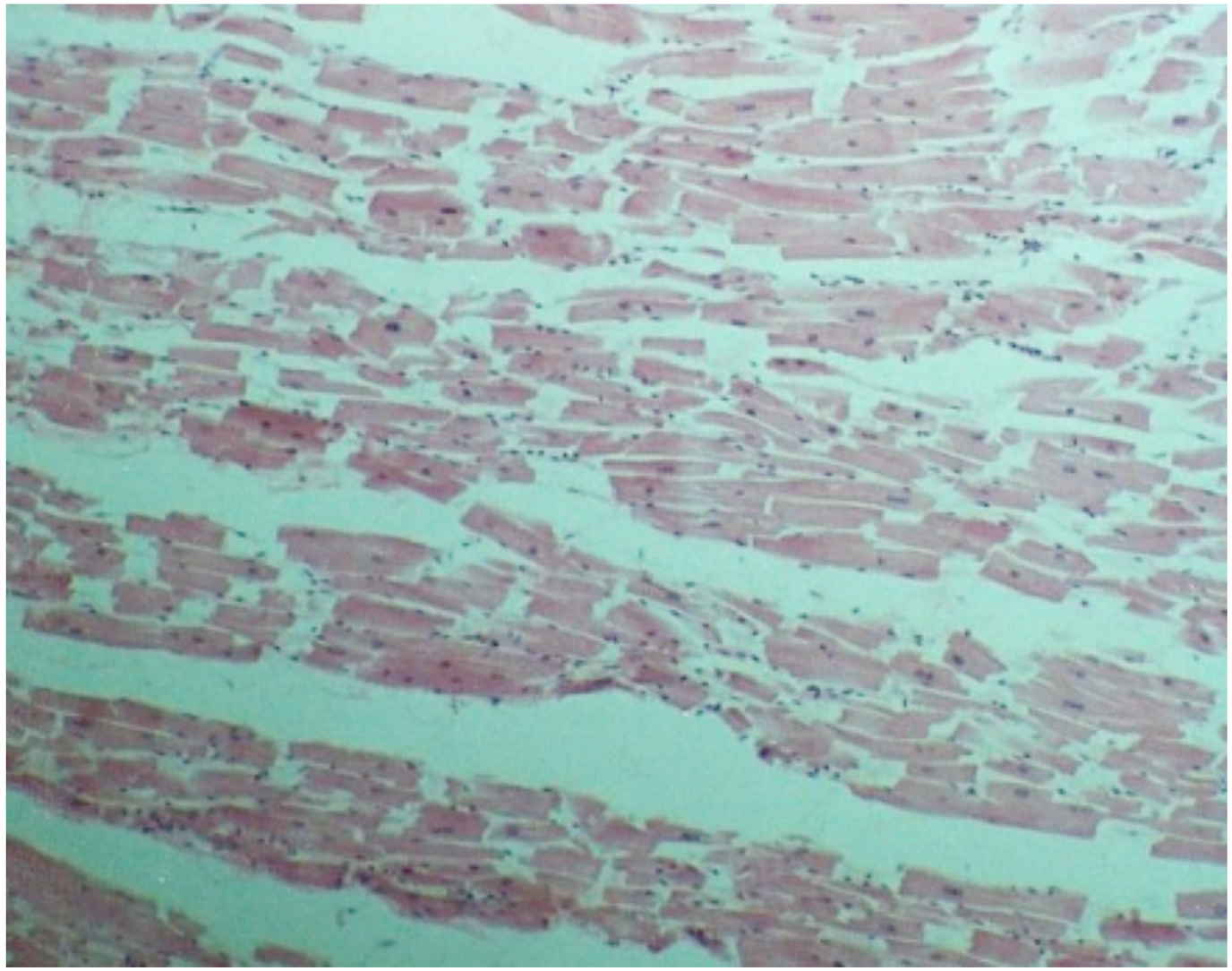


Variations of enzyme activity in myocardial tissues from animals in the experimental group (% vs control group).

The effects of Cs-137 are more intense on the cardiovascular system of a developing organism. A concentration of radioactive cesium over 10 Bq/kg leads to the alteration of electrophysiological processes in the myocardium of children. Those born after 1986 and living constantly in the territories contaminated by the Cs-137 concentration greater than 15 Ci/km_2 have serious pathological changes in their cardiovascular system, which are manifested clinically and on the electrocardiogram. The incorporation of Cs-137 in children causes the electrophysiological disorders of the myocardium, giving rise to the abnormal heart rate and rhythm.There was a definite correlation between the radionuclide contents in the body and the incidence of arrhythmia. [1-5, 7-10]



Number of children without ECG changes, as a function of Cs-137 concentration in the body.



Histological section of myocardium of a 43-year-old Dobrush resident who died suddenly. Radioactive cesium concentration in heart: 45.4 Bq/kg. Diffuse myocytolysis. Intermuscular edema. Fragmentation of muscular fibers. Stained with hematoxylin and eosin. Magnification x125.

Myocardial disorders are noted in 99% of death cases. One can observe here the diffuse involvement of muscle cells that is characteristic of the toxic effects of the incorporation of radioactive cesium.

Similar changes are found in laboratory animals, with the Cs-137 being ingested with food (oats) or as an aqueous solution.

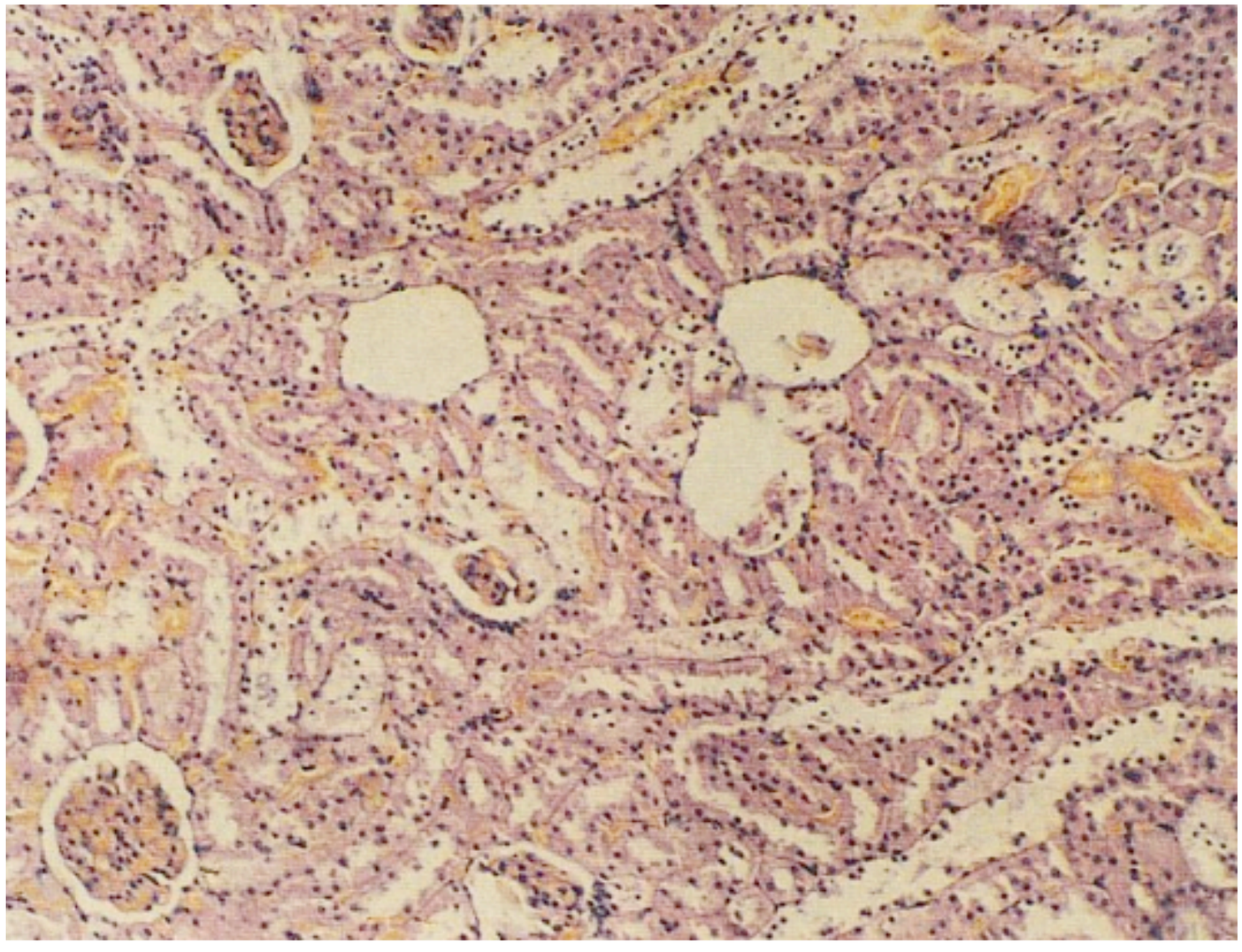
We define the myocardium pathology that we have described as cardiomyopathy as a result of the Cs-137 incorporation. It corresponds exactly to the definition of the committee of WHO experts: this type of cardiomyopathy was due to myocardial destruction of different etiologies other than inflammatory or coronary.[18]

Diffuse destruction of myocardial cells without obvious physiological responses may offer a perfect illustration of the cardiomyopathy due to the Cs-137 incorporation. The contribution of Cs-137 to a classical myocardial infarction is also considerable, as the reduction of the antithrombotic activity of the vascular wall and also the activation of the coagulation cascade promote the formation of blood clots in the lumen of the vessels.[20]

Involvement of the vascular system due to Cs-137 results in the increasing number of people suffering from severe diseases--such as arterial hypertension appearing even in young children.

Apart from the direct toxic effect of radioactive cesium, these pathological changes of vasculature induce cellular destruction in the brain, heart, kidneys and other organs. Also, despite much discussion among prominent cardiologists, it is the Cs-137 that we consider to be responsible for the cardiovascular system damage. [22] More material facts are to be considered. The presence of radioactive cesium in food and human bodies in the territory of the former USSR, Belarus, has been noted since the 1960's. (Marey AN, et al. 1974.) [19] The years since the 1960's were also marked by a substantial increase in morbidity and mortality from the cardiovascular diseases.

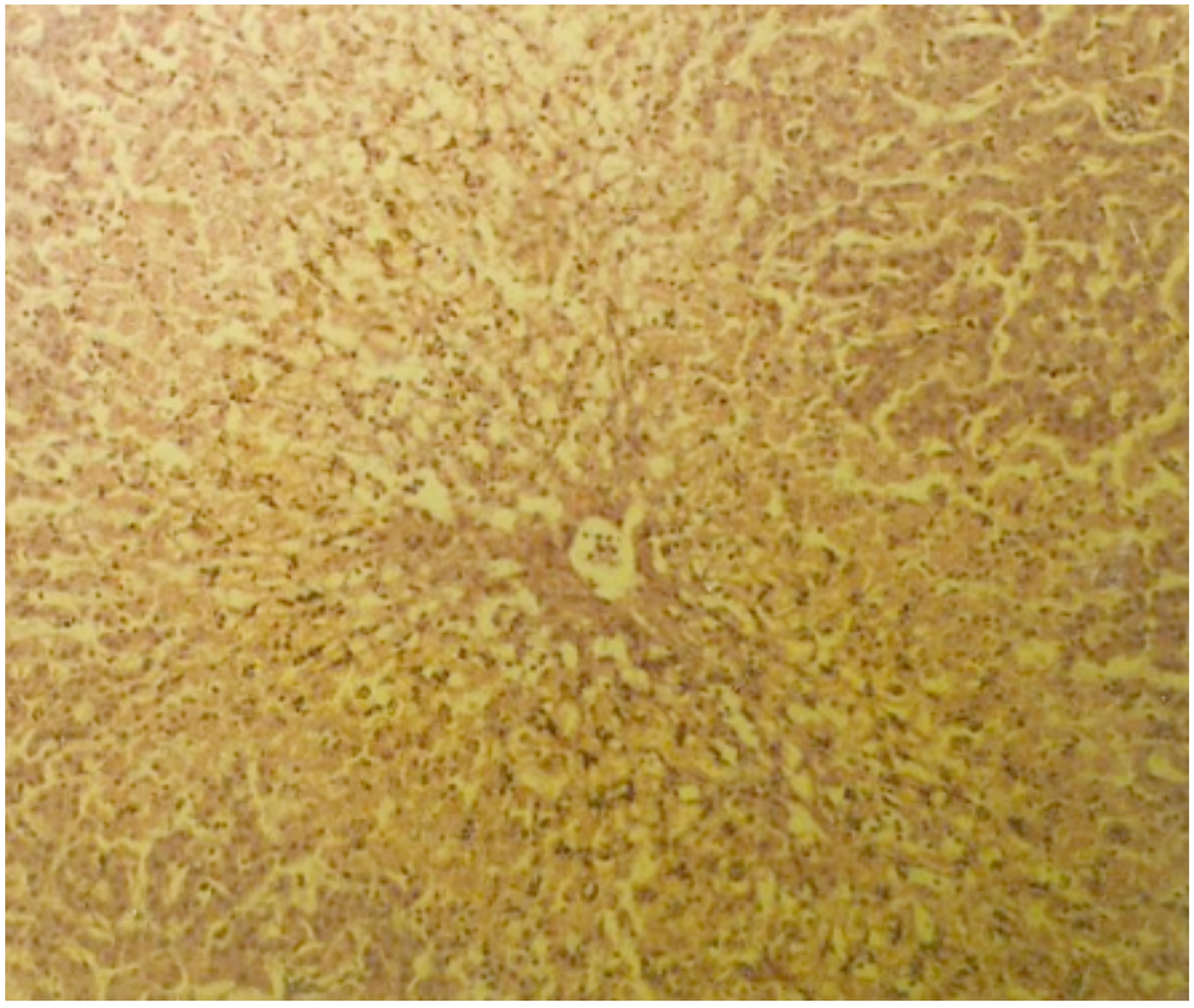
The kidneys are the key organ, governing the process of excretion of radioactive cesium from the body. According to V. Zhuravlev (1990) [17], the urinary excretion of Cs-137 is 6 to 9 times greater than the fecal excretion. It affects the vasculature of the glomeruli and tubules of the nephron. Destruction of structural and functional elements of the kidney, first and foremost the glomeruli, is manifested by a characteristic histological appearance called a "melting icicles" phenomenon. Considerable concentrations of Cs-137 were measured in the tissues of this organ.



Histological section of an albino rat kidney with a radioactive cesium concentration of 900 Bq/kg. Glomerular necrosis and fragmentation with cavity formation. Tubular epithelial necrosis and hyaline-droplets dystrophy. Stained with hematoxylin and eosin. Magnification x250.

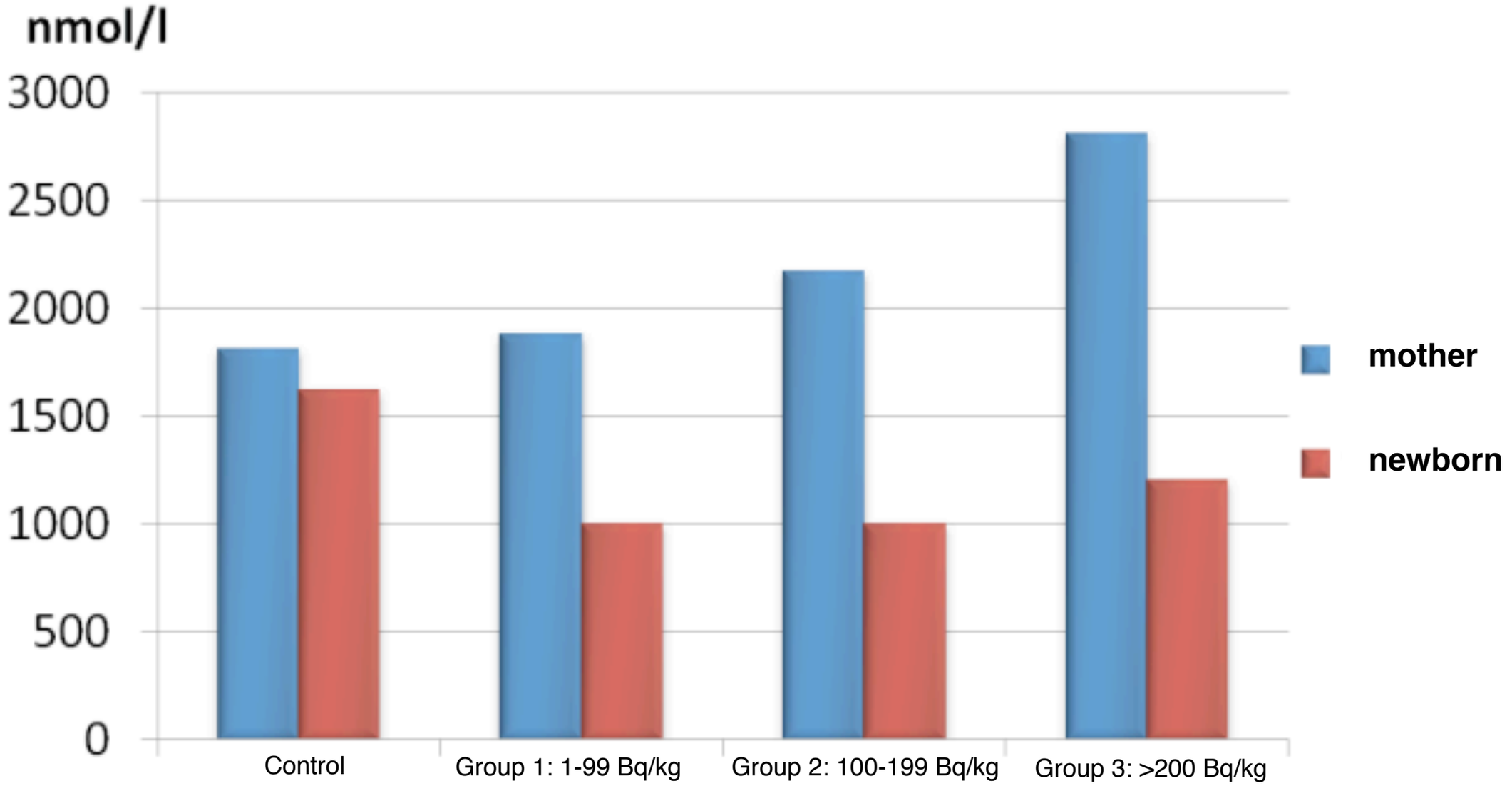
Because of the structural peculiarities of kidneys, the radiation-induced pathology of this organ has specific features. The disease is rarely accompanied by nephrotic syndrome: it is characterized by more severe and more rapidly progressing glomerulonephritis, rather than the ordinary chronic glomerulonephritis. It is also characterized by a frequent and early development of malignant arterial hypertension. It takes only 2 to 3 years for the degradation of the kidneys to lead to the development of chronic renal failure with cerebral and cardiac complications from hyperazotemia.

The destruction of the kidneys is one of the main reasons for the accumulation of Cs-137. It also causes the accumulation of metabolic waste products in the body, with toxic effects on the myocardium and other organs as well as the development of hypertension. In the study of cases of sudden death in Gomel, 89% of cases showed severely impaired kidneys, although they were never diagnosed before death.



Histological section of liver from a 40-year-old Gomel resident who died of sudden death. Radioactive cesium concentration in the liver was 142.4 Bq/kg. Protein and lipid dystrophy with necrosis of hepatocytes. Stained with hematoxylin and eosin. Magnification x125.

A serious pathological process called toxic dystrophy in the liver is noteworthy. The toxic dystrophy is characterized by changes in metabolism, leading to the decay of protein structures in cells and the formation of fat-like substances, contributing to a severe form of fatty liver and cirrhosis.



Cs-137 concentration in placenta.

Concentration of cortisol in the blood of the mother and the newborn.

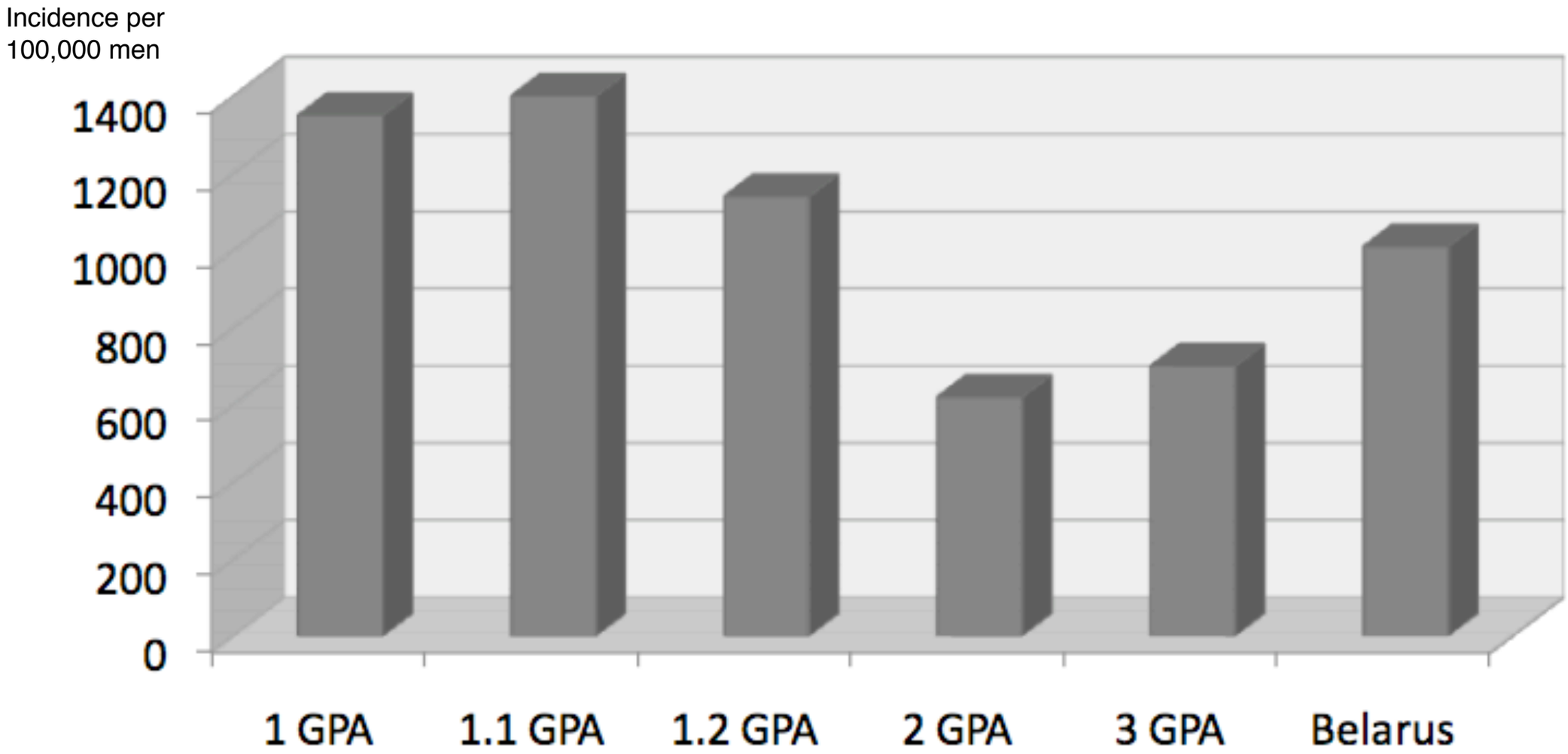
The endocrine system is exposed to the influence of the incorporated Cs-137. In particular, the adrenals are affected by the incorporation of radioactive cesium, with the cortisol level directly correlating with the concentration of radioactive cesium. Changes in the cortisol production are especially notable among newborns whose mothers accumulated large amounts of Cs-137 in the body, particularly in the placenta. Not surprisingly, these newborns are well known for maladaptation to their extrauterine existence.

Diseases of the female reproductive system are associated with an impaired endocrine function. The radioactive cesium is responsible for imbalances of the estrogen-progesterone ratio at different times of the menstrual cycle in women of childbearing age, which is a major cause of infertility.

The incorporation of radioactive cesium in the placenta and other endocrine organs during pregnancy gives rise to hormonal disorders in fetuses as well as mothers. In particular, the increase in the concentration Cs-137 raises the levels of testosterone as well as thyroid hormones and cortisol in the blood.

Distortion of the hormonal status of the mother-fetus system due to radioactive cesium leads to prolonged pregnancy. It also increases perinatal complications and complications of postnatal development of the newborn. When babies are breastfed, the radioactive cesium also goes into the body of the baby. Thus, the mother's body is purified of Cs-137, while the baby's body is penetrated with Cs-137. Many systems are forming during this period, and the radioactive cesium has extremely negative effects on the baby's body.

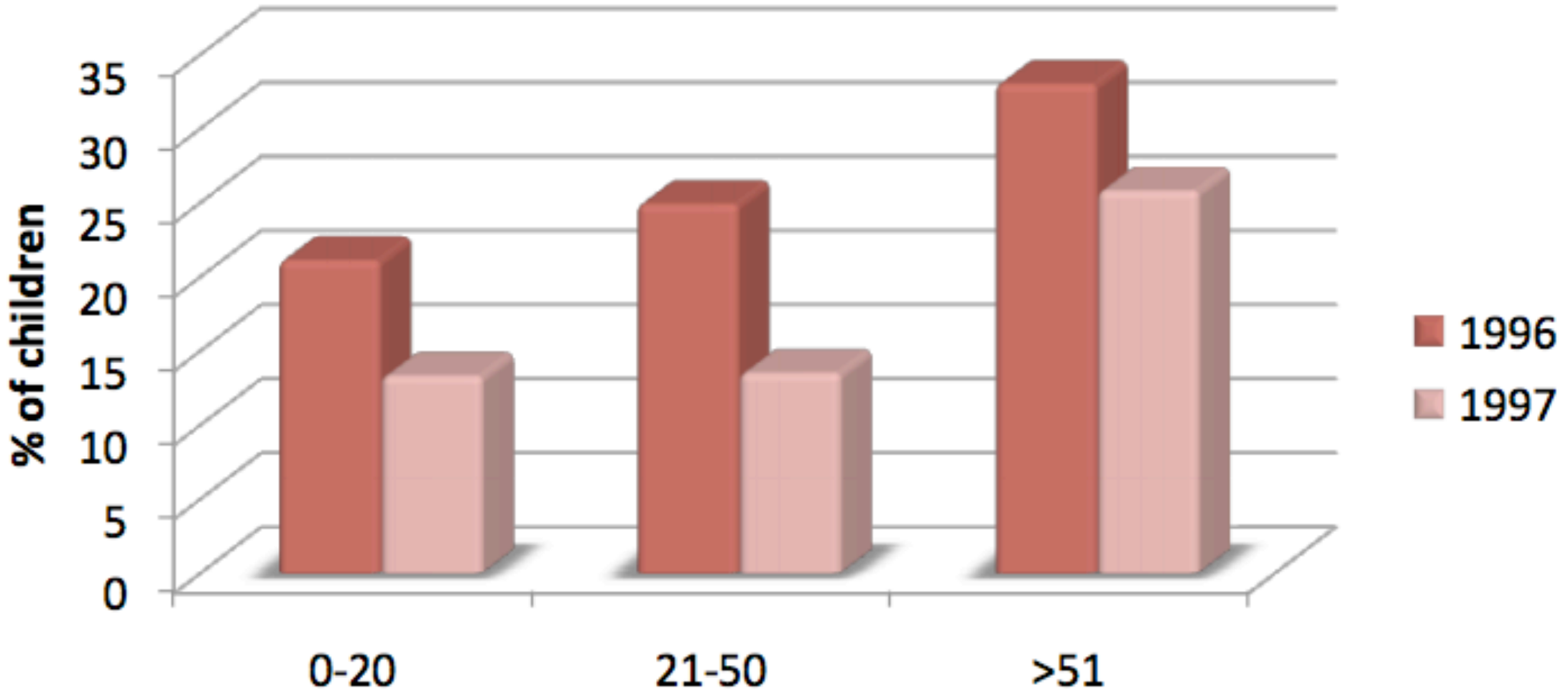
The nervous system is the first to be affected by the incorporation of radioisotopes. The incorporation of Cs-137 at a level of 40-60 Bq/kg, as in animals fed radioactively contaminated oats for 28 days, causes a distinct imbalance of biogenic monoamines and neuroactive amino acids in different parts of the brain, especially the cerebral hemispheres: this is characteristic of the lethal to above lethal doses of radiation. [7] This results in various autonomic disorders.



1. - The liquidators of the Chernobyl nuclear power plant
1.1. The liquidators of the Chernobyl nuclear power plant in 1986-1987.
1.2. The liquidators of the Chernobyl nuclear power plant in 1988-1989.
2. - Residents evacuated from the evacuation zone.
3. - Individuals residing in the area of primary resettlement.

Incidence of cataract in men affected by the Chernobyl disaster between 1993 and 2003.

Eyes are extremely sensitive to the incorporation of radioactive cesium. From 1993 to 2003 there was an average annual increase of 6% in the incidence of cataracts in male liquidators of the Chernobyl disaster. This is significantly higher than in the other male categories of affected population.



Average specific activity Cs-137

The dynamics of the incidences of cataracts in children in the Vetka district, Gomel region, according to the average specific activity of Cs-137 (Bq/kg) in the body.
(Bandazhevsky YI, et al. 1997, 1999.)[2,3]

The increased incidence of cataracts in school-age children living in contaminated territories should also be mentioned. The frequency of discovery of eye diseases is directly related to the quantity of Cs-137 in the body.

Thus, a long-living radioisotope Cs-137, penetrating into the body, adversely affects many vital organs and systems.

The result is the damage to the highly differentiated cells, the severity of which is in direct proportion to the amount of the incorporated radioactive cesium. At the heart of this process is the destruction of the energetic mechanism, leading to the disintegration of protein structures.

In this regard, a characteristic feature of the Cs-137 effects on the human body is the inhibition of metabolic processes in the cells of vital organs and systems, due to its direct effects, the effects of toxic agents formed (nitrogen compounds), and the disruption of tissue nutrition due to vascular damage.

These pathological changes found in humans or animals can be collectively called a “syndrome of the long-living incorporated radioisotopes (SLIR).”

The syndrome appears when the body incorporates Cs-137, with its intensity depending on the amount and duration of incorporation. It is characterized by the metabolic disorders caused by specific structural and functional alterations of the cardiovascular, nervous, endocrine, immune, reproductive, digestive, urinary, and hepatobiliary systems. The amount of Cs-137 required to induce SLIR may vary according to age, gender and the functional state of the body. In children, significant pathological changes were observed in organs and systems with an incorporation of Cs-137 over 50 Bq/kg. At the same time, metabolic disturbances, especially in the myocardium, were observed at a concentration of Cs-137 as little as 10 Bq/kg.

CONCLUSION

1. Twenty-three years after the accident at the Chernobyl nuclear power plant, the people of the Republic of Belarus, who have lived in areas contaminated by radioactive elements and continuously consumed these radionuclides through food over a long period are exposed to a risk of increased cardiovascular diseases and malignant tumors.

2. The steady increase of these diseases during the 23 years after the accident at the Chernobyl nuclear power plant has led to a situation that is near the demographic catastrophe where the mortality rate is almost twice the birth rate.

3. The current situation requires immediate actions at national and international levels to address the problem: the protection of the health of people living in the territories affected by the Chernobyl accident.

References:

1. Bandazhevsky GS. The state of cardiac activity in children living in areas contaminated with radionuclides. Medical aspects of radiation exposure on the population living in contaminated areas after the Chernobyl accident: Proceedings of the International Scientific Symposium. Gomel: 1994. p. 27.
2. Bandazhevsky Y. Pathophysiology of incorporated radioactivity. Gomel: Gomel State Medical Institute; 1997. p. 104.
3. Bandazhevsky Y. Pathology of incorporated radioactivity. Minsk: Belarusian State Technological University; 1999. p.136.
4. Bandazhevsky Y. Radioactive cesium and heart (pathophysiological aspects). Minsk: Belrad Institute; 2001. 62 p.
5. Bandazhevsky Y. Pathological processes in the body in the incorporation of radionuclides. Minsk: Belrad Institute; 2002. p. 142.
6. Bandazhevsky Yu.I. Chronic Cs-137 incorporation in children's organs. Swiss Med. Weekly 2003;133: 488-490.
7. Bandazhevsky YI, Lelevich VV, Strelkov VV, et al. Clinical and experimental aspects of the effects of incorporated radionuclides in the body. (Y. Bandazhevsky & V. Lelevich, Eds.) Gomel: 1995. p. 173.
8. Bandazhevsky Y, ed. Structural and functional effects of incorporated radionuclides in the body. Gomel: 1997. p. 152.
9. Bandajevsky Yu.I, Bandajevskaya G. Cardimyopathies au cesium 137. CARDINALE (Paris), XV: № 8, p. 40-42; Octobre 2003.
10. Bandazhevsky I. Medical and biological effects of incorporated radioactive cesium in the body. Minsk: 2000. p. 58.
11. The population health in Europe. Report on monitoring measures to obtain health for everyone in 1993-1994. European edition, № 56. Copenhagen: Regional VOZ publications; 1995.
12. Healthcare in the Republic of Belarus. Official statistical compilation. Minsk: 2006. p. 275.
13. Health and Medical Science in Belarus. Statistics of the Ministry of Health in Belarus. 2006 Dec 1. Available from URL: http://stat.med/by
14. Mortality in the Republic of Belarus for 2004-2005. The official statistical yearbook. Minsk, 2005./Sostaviteli: Ministry of Health, the sector analysis methodology and medical statistics. Minsk: State RNMB, 2006. p. 181.
15. Shevchuk VE, Gurachevsky VL, eds. 20 years after the Chernobyl accident. Consequences in the Republic of Belarus and their overcoming. National Report of the Committee on Problems of the Consequences of the Chernobyl NPP under the Council of Ministers. Minsk: 2006. p. 110.
16. Atlas of cesium contamination of Europe after the Chernobyl accident in 1998.
17. Zhuravlev VF. Toxicology of radioactive substances. 2nd ed. Revised. M. Energoatomizdat, 1990. p. 336.
18. Cardiomyopathy. BED(Great Medical Encyclopedia). V. 10. 1979.
19. Marey AN, Barkhudarov RM, Novikova NJ. Global fallout Cs-137 and people. Atomizdat, 1974. p. 168.
20. Tlepshukov IK, Baluda MV. Violations hemostatic homeostasis in liquidators of the Chernobyl nuclear power plant. Cardiology 1998; 38: 48-50.
21. Piliptsevich NN, Breaking LN, Gal'burt GN. The main health indicators of Belarus in the 1990s. Achievements of medical science in Belarus 2001;6.
22. Sidorenko GI. Prevention of cardiovascular disease: an urgent task of modern medicine. Medical News 1999;1-2: 4-8.

Non-cancerous Medical Conditions in Areas of Belarus Contaminated by Radioactivity from the 1986 Chernobyl Nuclear Accident

Official authorized version

Design by Shino Yasutomo

www.bandazhevsky.org