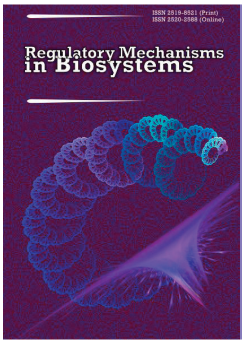

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Demographic and onco-epidemiological situation in radioactive contaminated territory of Zhytomyr Oblast

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We performed an assessment of demographic parameters of occurrence of malignant tumours and mortality of the population which lives in the radioactive contaminated territory of Zhytomyr Oblast (Yemilchynskyi, Luhynskyi, Narodytskyi, Korostenskyi, Olevskyi, and Ovrutskyi districts) over a 32-year period (1985–2017). The source material for the study of the demographic situation and malignant tumours in the population of the radioactive contaminated administrative districts of Zhytomyr Oblast during 1985–2017 was the statistical data of the Management of Healthcare of Zhytomyr Oblast State Administration, Central Department of Statistics in Zhytomyr Oblasts, reports on occurrences of malignant tumours of the state institution Center of Medical Statistics of the Ministry of Healthcare of Ukraine, data of the Radiological Control Service in Zhytomyr Oblast. It was determined that over 1985–2017 in the radioactive contaminated territory of Zhytomyr Oblast, a natural decline of population was observed, maximum values of which occurred in 2005 (except Narodnytsky district – 2000). The highest levels of occurrence of tumours and mortality caused by them among the adult population were observed 14 years after the Chornobyl nuclear power plant disaster. The peak of the occurrence of malignant tumours among children in the radioactive contaminated territory of Zhytomyr Oblast was observed 9 years after the explosion. A relationship was determined between doses of irradiation of the population and the risk of occurrence of malignant tumours in the radioactive contaminated regions of Zhytomyr Oblast. Taking into account that the method of calculation of passport dose (average annual effective dose of irradiation) was developed 23 years ago, nowadays it can lead to errors. This is related to change in amounts of consumption of different products by the population, which needs to be considered when determining radiological risks. The obtained data indicate that analysis of demographic and onco-epidemiological consequences of the Chornobyl catastrophe remains a relevant issue nowadays and will remain so in the near future.

Keywords: natural decline of population; birth rate; mortality; malignant tumours; risk of occurrence of disease; acceptable levels of content of ^{137}Cs activity in food products.

Introduction

The existing crisis in the ecological situation, demographic parameters, and way of life of the population of Ukraine condition the increase in the level of oncological diseases and mortality from cancer even in people of relatively young age (Domina, 2015; Antoniv et al., 2017; Wilke et al., 2018). One of the main factors of increase in the carcenogenesis is the Chornobyl nuclear power plant explosion (Brown, 2017; Cucu et al., 2018; Jargin, 2018; Seo et al., 2018). It was the largest radiation-related industrial accident of the past century (Saenko et al., 2011; Kortov & Ustyantsev, 2013), and the consequences of the negative impact of radiation can be found many years later (Kravchenko, 2016). The Chornobyl nuclear power plant explosion caused radioactive pollution of 29.9 km^2 of the territory of Zhytomyr Oblast with ^{137}Cs and ^{90}Sr and significant irradiation of the population (Malynovskiy et al., 2006; Prister, 2007; Bazuka, 2016).

The problematic of radioactive emissions as a result of the Chornobyl tragedy is described in a number of studies by Ukrainian, as well as foreign scientists. Particularly, study on the assessment of the demographic situation in radioactive contaminated territory of Ukraine has been conducted by Dubova & Gunko (2010), Omelyanets et al. (2015); on radioactive risks of larynx cancer in patients in the territory of the Russian Federation – Antoniv et al. (2017); neoplasm of the thyroid in the population of contaminated regions of Ukraine – Kravchenko (2016), Tronko et al. (2017); papillary thyroid cancer in children of Belgium – Michel et al. (2016); meningiomas in the population of the north-east part of Romania – Cucu et al. (2018); leukemia in children of Sweden – Hjalmars et al. (1994).

The extent of anti-radiation measures, medical and social protection of inhabitants of radio-contaminated territories was insufficient and has not completely prevented radioactive risks for health (Gunko, 2015; Kashparov, 2016; Omelianets et al., 2016), which need to be continued to be monitored (Hatch et al., 2015; Tronko et al., 2017; Bazyka et al., 2018; Volosovets et al., 2018). The obtained data indicate not only the unsatisfactory condition of the irradiated population according to parameters of birth and death rate (Dubova & Gunko, 2010; Grech, 2014; Omelianets et al., 2016), but also the decrease in the population's vitality (Omelyanets et al., 2015; Sushko et al., 2018).

Degradation of the settlements in the zone of unavoidable (necessary) eviction of the population, which has developed over recent decades due to absence or lack of finances for their social-economic rehabilitation and the low standard of living of the inhabitants increase risks from the impact of ionizing radiation and require continuation of anti-radiation measures, including resettlement.

Generalization of the data on the extent of organised migrations caused by the Chornobyl catastrophe indicate that absolute risk of territorial ecological migration for Ukraine equals $3.2·10^{–3}$, including: risk of evacuation – $1.8·10^{–3}$, risk of organized resettlement – $1.4·10^{–3}$. The extent of territorial risks for radioactive contaminated administrative units has a broad range of values. In particular, for Zhytomyr Oblast it equals $3.3·10^{–2}$, including: risk of obligatory resettlement – $1.2·10^{–2}$, risk of voluntary resettlement – $2.1·10^{–2}$, Narodytskyi district – 0.77, 0.62, 0.15, Ovrutskyi district – 0.84, $2.6·10^{–2}$, 0.82, Luhynskyi district – 0.2, $4.0·10^{–2}$, 0.16, respectively. For the towns of Prypiat and Chornobyl the risk of evacuation equaled 1 (Bazuka, 2016). Accordingly, assessment of demographic and onco-epidemiological situation in the radioactive contaminated territory of Zhytomyr Oblast is exceptionally relevant.

The objective of our study was assessment of the parameters of occurrence of malignant tumours and mortality of the population in the radioactive contaminated territory of Zhytomyr oblast over a 32-year period (1985–2017).

Material and methods

The basis for studying the demographic situation and risks of the malignant tumours among the population of radioactive contaminated administrative districts of Zhytomyr Oblast over the 1985–2017 period was statistical data of the Management of Healthcare of Zhytomyr Oblast State Administration, the Central Department of Statistics in Zhytomyr Oblast, reports on occurrences of malignant tumours (form No 7) of the state institution Center of Medical Statistics of the Ministry of Healthcare of Ukraine, data of the Radiological Control Service in Zhytomyr Oblast.

Results

In the radioactive contaminated territories, changes in the age composition in the direction of ageing of the population occurred due to departure of mostly working-age people, pregnant women and families with children. The birth rate declined especially sharply during the first years after the Chornobyl disaster (Fig. 1).

Accordingly, in 2017, compared to 1985, the coefficient of birth rate was lower by 18.5% (Korostenskyi district) and by 44.8% (Ovrurskyi district). In all years after the explosion at the Chornobyl power plant, in the radioactive contaminated territories, heightened levels of mortality of the population and worsening of reproductive behaviour were observed (Fig. 2, 3). As a result of the disproportion between birth rate and mortality, parameters of vitality of the population reduced and its reproductive potential decreased. The highest values of natural decline of the population of radioactive contaminated regions of the Oblast were recorded in 2005 (except Narodytskyi district – 2000) (Fig. 3).

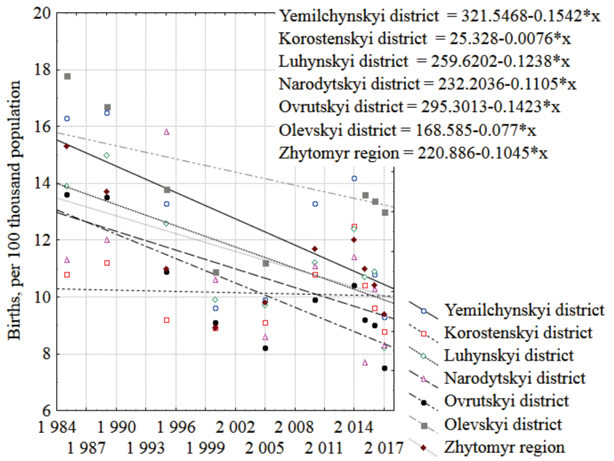

Fig. 1. Coefficients of birth rate of the population of radioactive-contaminated territories of Zhytomyr Oblast over 1985–2017

Among the main causes of mortality of the population of Zhytomyr Oblast, there are distinguished diseases of the blood circulatory system (69%), oncological diseases (11.5%) and external factors (6.6%). In the structure of the causes of mortality of the population, tumours have taken second place for a long period of time. In 2017, in Zhytomyr Oblast, for the first time 3,999 cases of cancer were found (1,986 cases in men, and 2,013 in women), which equals 322.2 per 100 thousand of the population (against 3,906 cases of cancer in 2016, which is 312.9 per 100 thousand of the population). Furthermore, currently 29,253 people live in the territory of the Oblast, who have already suffered from an oncological disease.

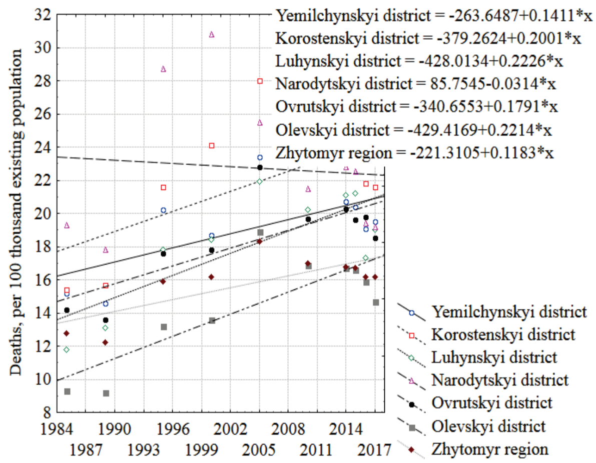

Fig. 2. Coefficients of death rate of the population of radioactive-contaminated territories of Zhytomyr Oblast over 1985–2017

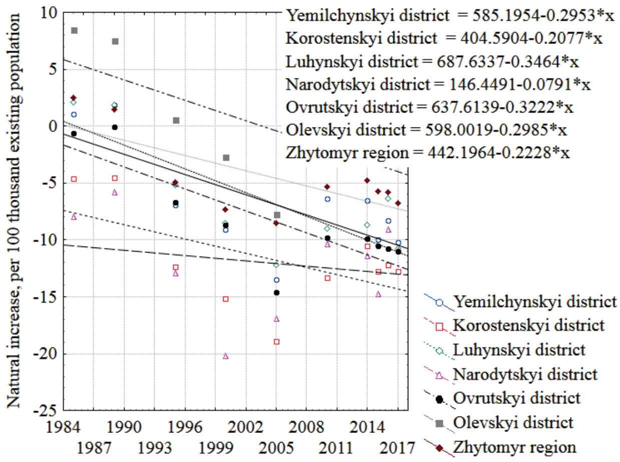

Fig. 3. Natural decline of the population of radioactive contaminated territories of Zhytomyr Oblast in the period 1985–2017

The peak of the disease among the population of the administrative districts of Zhytomyr Oblast, affected by the Chornobyl power plant explosion, occurred in 2000, when the risk of the disease was higher than the parameters before the explosion by 2.2 (Yemelchynskyi district) and 4.6 (Olevskyi district) times. This tendency remained in 2015, when this parameter for malignant tumours in the population of the Olevskyi district reached 332.5 per 100 thousand of the population. The maximum level of risk of the disease in 2017 occurred in the territory of Yemilchynskyi district – 315.3 per 100 thousand of the population (Fig. 4).

The tendency towards increase in occurrence of malignant tumours during the post-explosion years is seen also in the child population (Fig. 5).

The peak of occurrence of malignant tumours among the child population took place in 1995: compared to the pre-explosion period, the risk of the disease had increased by 9.5 times in Narodytskyi district and 10 times in Ovrutskyi district. Risk of the disease among children in the radioactive contaminated areas of the Oblast over 2000–2017 equaled 0.08–0.60 per one thousand of the child population (in 1995 – 0.5–5.9 per one thousand of the child population). Maximum parameters of the disease in the child population during 2000–2017 at the level of 0.5 and 0.6 was recorded in 2015 in Narodytskyi district and in 2016 in Luhynskyi district respectively; minimum – 0.08 in 2000 and 0.1 in 2017 in Ovrutskyi district (Fig. 5).

As at 2017, among the monitored administrative districts the territory of which was affected by the explosion at the power plant, the highest number of oncology patients among children lived in Luhynskyi and Yemilchynsky districts – 125.0 and 114.3 per 100 thousand of the child population. In Narodytskyi district as at 2017, there were no 0 to 17 year old children with oncological pathology, which could be related to resettlement of the population to conditionally clean areas (Fig. 5).

Localization of malignant tumours in 2017 in the population of certain districts of Zhytomyr Oblast is presented in Figure 6. The structure of occurrence of malignant tumours looks as follows: mammary gland (18.1%) > body of the womb (14.2%) > lungs (13.8%) > skin (12.0%) > cervix (11.1%) > ovaries (9.0%) > stomach (7.4%) > rectum (5.7%) > thyroid (4.1%) > oral cavity (3.1%) > vulva (1.5%). We should note that the structure of localization of malignant tumours in radioactive contaminated districts of Zhytomyr Oblast in general varies.

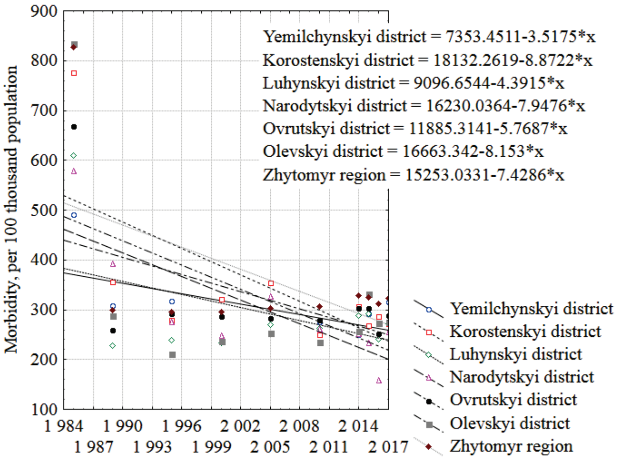

Fig. 4. Occurrence of malignant tumours (large-scale parameter) in certain districts of Zhytomyr Oblast in 1985–2017

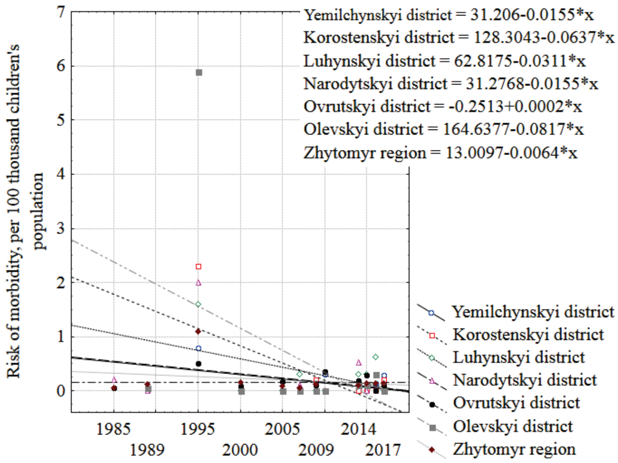

Fig. 5. Risk of occurrence of malignant tumours among children in certain districts of Zhytomyr Oblast in 1985–2017

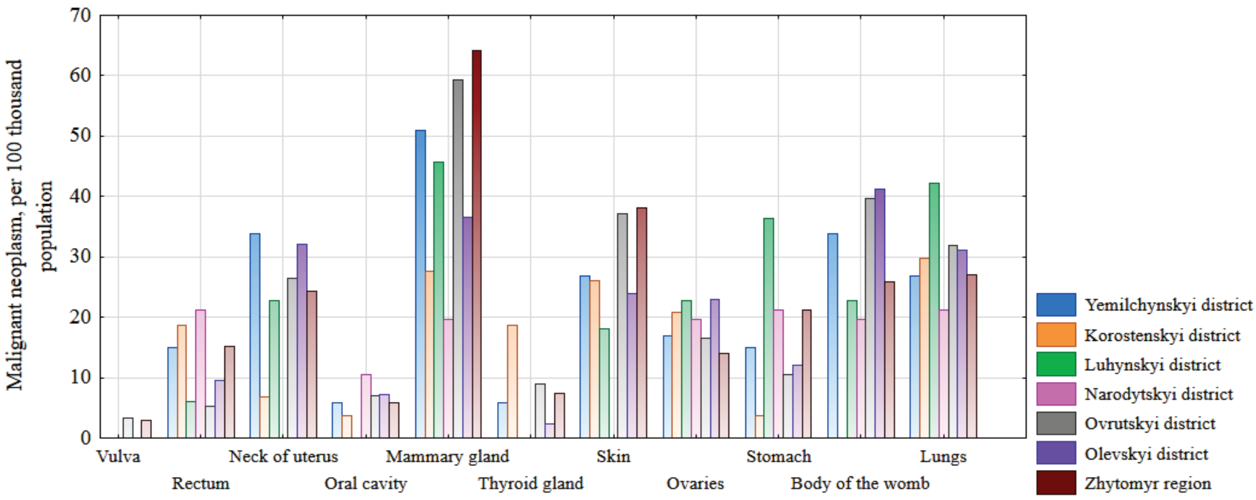

Fig. 6. Localization of malignant tumours in the population of radioactive contaminated districts of Zhytomyr Oblast, 2017

In the structure of the death rate of the population of the Oblast in 2017, tumours were in the second place after cardiovascular diseases and equaled 11.5% (against 12% in 2016 and 11.4% in 2015). We should note that in the structure of mortality of the population of the towns, this type of cause of death was slightly more significant compared to the population of the rural areas: 14.2% against 8.8%.

Mortality of the population of the districts of Zhytomyr Oblast affected by the Chornobyl nuclear power plant explosion in general correlates with the parameters of morbidity (Fig. 7). The risk of mortality of the population surpassed the average level for the Oblast during 2000–2009 in Yemelchynskyi district; during 2000–2009 and 2014–2015 in Korostenskyi, in 2017 in Narodnytskyi; during 2000–2014 in Luhynskyi; and in 2005 and 2016 in Ovrutskyi district (Fig. 7).

In 2017, in the Oblast, the proportion of the diseased who died a year after the diagnosis was 26.8%. In particular, in Yemelchynskyi district this parameter equaled 28.9, in Korostenskyi – 32%, Narodytskyi – 28.6%, Luhynskyi – 30.8%, Ovrutskyi – 30.1%, Olevskyi – 21.1%. The leading position in the structure of mortality of those who died in the year since diagnosis, among the population of the radioactive contaminated regions of Zhytomyr Oblast, belongs to death from malignant tumours of the digestive organs – 40.4% (Fig. 8).

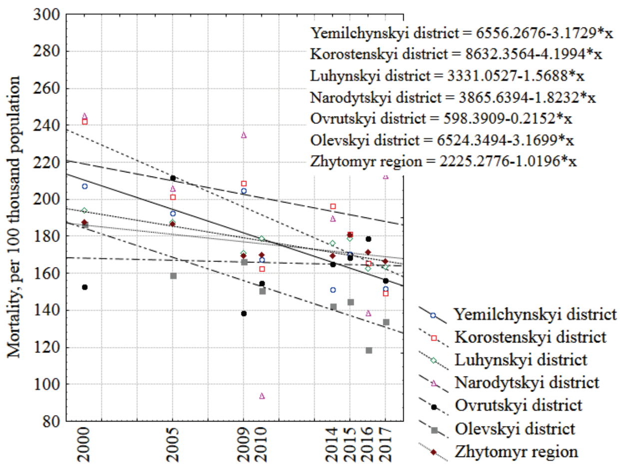

Fig. 7. Death rate of the population of certain districts of Zhytomyr Oblast caused by malignant tumours in 2000–2017

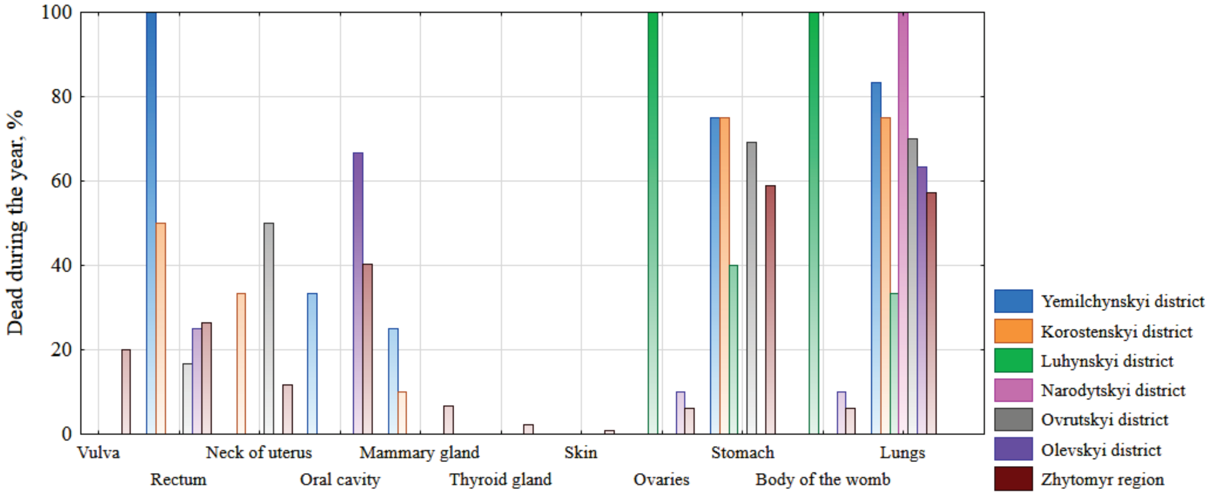

Fig. 8. Proportion of people who died of malignant tumours in radionuclide-contaminated districts of Zhytomyr Oblast, 2017

The state of oncological help to the population is determined by the parameters of diagnostics and treatment. Diagnosing tumours at early stages of their development is essential for treatment and prolonging of life expectancy of the patients. The level of the development of diagnosis of oncological diseases can be seen in the value of share of patients of IV clinical group among the patients diagnosed for the first time (Fig. 9).

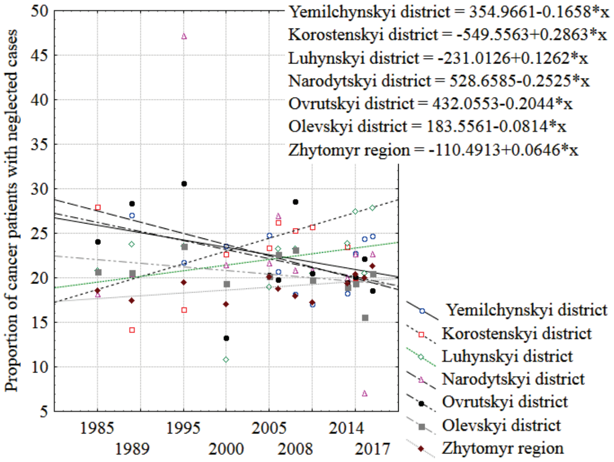

Fig. 9. Share of patients of IV clinical group with malignant tumours in certain districts of Zhytomyr Oblast over 1985–2017

During the studied period, this parameter changed practically in the same way: both in 1985 and 2017 each 4–5th case of malignant tumour was diagnosed at IV stage of the development. In 1995, in radioactive contaminated districts of the Oblast, out of the total number of patients who were diagnosed with cancer for the first time, 21.7% (Yemilchynskyi district), 16.4% (Korostenskyi district), 23.6% (Luhynskyi and Olevskyi districts), 47.2% (Narodytskyi district), 30.6% (Ovrutskyi district) of cases of the disease were recorded at the IV stage of the development. In 2017, oncological diseases on the IV stage of development were diagnosed in 24.7% (Yemilchenskyi district), 34.8% (Korostenskyi district), 27.9% (Luhynskyi district), 22.7% (Narodytskyi district), 18.6% (Ovrutskyi district), 20.5% (Olevskyi district) of the patients.

A close relationship was determined between the doses of irradiation of the population and risk of the occurrence of malignant tumours in radioactive contaminated districts of Zhytomyr Oblast in 2012; it was described as a linear equation D = 327.2159 – 1.8395 • x (R = 0.735), where D – risk of occurrence of the disease per 100 thousand of the population, x – dose of irradiation of the population.

Currently, in the formation of total dose of irradiation of the population of radioactive contaminated territories of Zhytomyr Oblast, the dominating factor has been the contribution of ^{137}Cs, which is consumed with locally produced food products. The Service of Radiological Control in Zhytomyr Oblast constantly monitors the levels of radioactive pollution of the products of agriculture and forestry and determines their correspondence to the acceptabled norms.

Figure 10 demonstrates data on the number of samples of food products which the Service analyzed and the share of excesses over the acceptable levels of activity of ^{137}Cs in food products in the districts most affected by the Chornobyl nuclear power plant explosion in 2000–2017. During this mentioned period, a systematic excess over the acceptable levels of the activity of ^{137}Cs in food products was determined in all of the studied districts of Zhytomyr Oblast. The highest share of excesses in acceptable levels was observed in Ovrutskyi and Narodytskyi districts, the most radioactive contaminated administrative units in the Oblast. Against the background of a general tendency in the Oblast towards reduction of cases of excess over the acceptable levels, in these districts, quite high parameters are constantly observed.

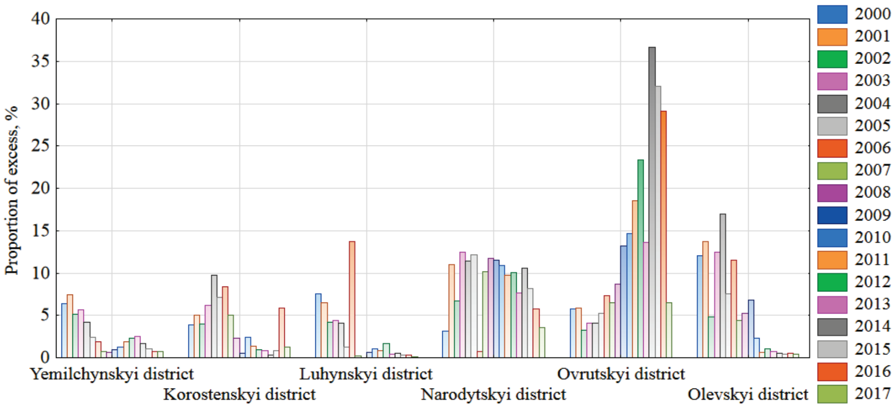

Fig. 10. Share of excesses over the acceptable levels of ^{137}Cs activity in food products in districts of Zhytomyr Oblast in 2000–2017

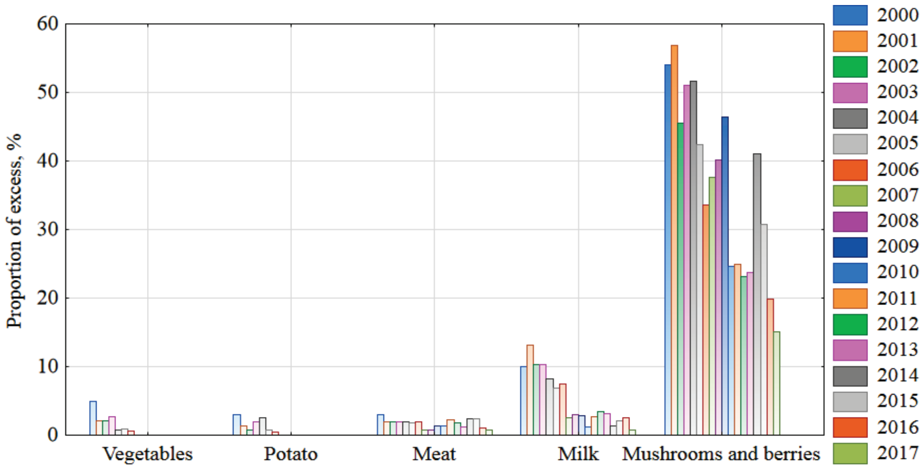

Fig. 11. Share of foods with excesses over the acceptable levels of ^{137}Cs activity in food products in Zhytomyr Oblast in 2000–2017

Within the selected samples of food products, the highest number of excesses over the acceptabled levels was recorded in forest berries and mushrooms (Fig. 11). On average, for six contaminated districts over 2000–2017, excesses were observed in 56.9–15.1% of analyzed samples of forest berries and mushrooms. In certain years, excesses over the acceptable levels of ^{137}Cs content in forest berries and mushrooms in territory of Korostenskyi, Luhynskyi, Narodytskyi, and Ovrutskyi districts were recorded in 75–100% of the samples.

Agricultural production was observed to have much lower levels of radioactive contamination than the products of the forest ecosystems. Share of the excesses of the acceptable norms of ^{137}Cs in agricultural production was much lower. Excess over the acceptable levels in the vegetables and potatoes in 2000–2017 was observed only in 0.03% of the analyzed samples. Since 2010, no excesses over the acceptable levels were observed in the products of plant origin from the territories of private farms.

Compared to the vegetables and potatoes, slightly higher levels of the ^{137}Cs activity were observed in the products of animal origin – milk and meat. Over 2000–2017, there was observed a decrease from 13.2 to 0.8% in occurrences of cases of ^{137}Cs content surpassing the acceptable norms in the samples of milk from cows. Over the years, share of the excesses over permissible levels of ^{137}Cs activity in milk has been observed to decrease. During the past decade excesses over the acceptable levels have occurred only in 0.8–3.4% of the cases.

Activity of ^{137}Cs in meat surpassed the acceptable levels in 0.7–3.0% of the analyzed samples. At the same time, it should be noted that most cases of excesses were observed in the samples of meat of wild animals.

Discussion

Prylypko & Ozerova (2011) mention that over the years after the Chornobyl nuclear power plant explosion, the level of understanding of the radioactive risk among the population of the polluted territories remains high, as well as among the population of conditionally clean territories, and 50–75% of the inhabitants of all settlements consider it possible to lose health precisely on account of environmental pollution.

In a study by Volosovets et al. (2018) it was determined that excesses in the parameters of occurrence of diseases in the child population (+23.2%) occur particularly in radioactive contaminated territories compared to other areas. Increase in the risk of late cancer of the thyroid, especially among those who were irradiated by iodine in their childhood and teens, was pointed out by Michel et al. (2016), Cherenko et al. (2017) and Yamashita et al. (2018). The latent period of radioactive-induced cancer of the thyroid, related to the explosion at the Chornobyl power plant, begun in 4-5th years after the explosion (Cherenko et al., 2017; Weiss, 2018) and lasts much longer than 30 years (Cherenko et al., 2017).

Doses of irradiation of the population of the contaminated territories are considered the most important characteristic of the consequences of the Chornobyl nuclear power plant explosion for people's health (Baverstock & Williams, 2006; Kravchenko, 2016; Michel et al., 2016). In the genesis of oncological diseases, a significant role may belong to irradiation of the population (Kaiser et al., 2016). Mean total doses of internal and external irradiation of the population of the affected regions of Zhytomyr Oblast equaled 1.91–42.4 mSv during 1986–2000, and 2.0–45.8 mSv during 1986–2012 (Diduh et al., 2006; Likhtarov, 2013).

Over the period remote from the Chornobyl nuclear power plant explosion, the doses of irradiation of the population are conditioned mainly by internal irradiation and are determined by concentration of radionuclides in final products of agriculture (Prister, 2007). A matter of concern is also the quality of the vegetable products grown on the land of private farms (Valerko et al., 2018). Therefore, agricultural activity can be orientated towards not exceeding the acceptable levels of content of radionuclides in all products, without exception (Prister, 2007).

The state hygienic norms "Acceptable levels of content of ^{137}Cs and ^{90}Sr radionuclides in food products and drinking water" were developed on the requirement that content of ^{137}Cs and ^{90}Sr radionuclides in food products and drinking water should not exceed the accepted threshold of annual effective dose of internal irradiation over 1 mSv. Control of the contamination of agricultural production is the most important aspect in the system of radioactive safety. Radiological control of the quality of agricultural products produced in contaminated territories is performed by measuring concentration of ^{137}Cs in them as the main dose-forming radionuclide (Prister, 2007).

Since 1992, in the contaminated territories, the content of radiocaesium in the organism of inhabitants is monitored regularly using human irradiation-measuring devices. Results of such measurements are used for assessment and control of factual content of radiocaesium in the organism of the inhabitants, conditioned by consumption of radioactive-contaminated food products (Likhtarov, 2013). Results of the dosimetric reflect the factual situation. In most settlements, the determined component of internal irradiation by the passport dose exceeded (sometimes significantly – up to 30 times) the dose of internal irradiation obtained by the irradiation-measuring devices monitoring, which is related to quite high level of conservatism of particularly the passport doses (Likhtarov, 2013). Likhtarov (2013) thinks that passport doses do not always accurately assess the radiological situation in a settlement. The generally accepted method of assessment of the passport dose was developed by Likhtarov et al. (1996) 23 years ago, and nowadays can lead to errors.

The dose of irradiation of the population is determined according to the concentration of radionuclides in the final products of agriculture, and also to a high extent according to food habits of a local population (Raychuk, 2015; Beresford et al., 2016). Consumption of the products of private farms and a large amount of meat and milk in the diet of the population condition large introduction of radionuclides to the human organism (Beresford et al., 2016; Furdychko, 2016).

Over the time passed since the explosion, scientific studies have revealed a number of factors which slightly change the mechanism of dose load on the inhabitants of the regions affected by the Chornobyl nuclear power plant tragedy. First of all, these changes are those that occur in the production and consumption of agricultural products by the locals (Raychuk, 2015; Beresford et al., 2016; Furdychko, 2016). Over these years, the amounts of consumption of different products by the population, including those produced locally, have changed, for example the amount of consumption of milk has reduced due to the decrease in the number of cows in the private sector. Furthermore, for the inhabitants of the Polesia regions, a large amount of products of the forest ecosystems – berries and mushrooms, is traditional in the diet. Despite the fact that the so-called "forest gifts" are not the main products of the population's diet (according to the diet recommended by the Cabinet of Ministers), their contribution to the formation of the dose of internal irradiation is quite high (Raychuk, 2015; Beresford et al., 2016). The contribution of consumption of forest berries and mushrooms to the total dose of internal irradiation of the rural population of the Polesia zone equals 20% on average (Prister, 2007). At relatively low levels of density of the contamination in the territory (3–5 Ci/km^2) of forestries of the Polesia, specific activity of the food products of forest origin can surpass the accepted levels by ^{137}Cs. Thus, forest products are a serious modifying factor of dosage load on the inhabitants of the settlements of the abovementioned area (Raychuk, 2015).

Kashparov (2016) emphasizes the fact that production of agricultural products which meet the radiation and hygienic norms is impossible in a part of radioactive polluted territory of Ukraine. In his study, he mentions that among post-Chornobyl problems, rehabilitation of the settlements is the most significant and difficult one, for it requires solving a complex of radiological, economic, demographic and social-psychological problems.

Analysis of demographic and onco-epidemiological consequences of the Chornobyl catastrophe indicates that the minimization of the aftermath and increase in the efficiency of medical treatment for the people affected by the radiation are not only relevant, but are should be a priority in the next few years. Particularly, the necessity of continuation of the studies on assessment of long-term consequences of the Chronobyl explosion is mentioned in the studies by Baverstock & Williams (2006), Saenko et al. (2011), Piciu (2013), Aitsi-Selmi & Murray (2016). The importance of continuing monitoring of the characteristics of long-term picture of ^{131}I risk in the groups affected by the iodine irradiation in childhood and teens is emphasized in the study by Tronko et al. (2017), Domina (2015) and Prykashchykova et al. (2018). Domina (2015) outlines that considering the radioecological situation in Ukraine, development and implementation of a strategy of effective initial prevention of radiogenic cancer must take place at an individual level. Aitsi-Selmi & Murray (2016) consider that accurate assessment of the radioactive risks can be performed only by studying the population throughout their natural life span.

Conclusion

In the period 1985–2017, in the radioactive contaminated territory of Zhytomyr Oblast, demographic tendencies were negative. In the structure of mortality of the population of Zhytomyr Oblast, tumours are in the second place, and 99.2% of them are malignant tumours. The peak of the occurrence of malignant tumours among the adult population of the affected administrative districts of Zhytomyr Oblast occurred in 2000, when the risk of the disease exceeded the pre-explosion parameters by 2.2 (Yemilchenskyi district) and 4.6 (Olevskyi district) times. Maximum level of occurrence of the disease took place in 2017 in the territory of Yemilchynsky district – 315.3 per 100 thousand of population. The peak of malignant tumours among the child population was observed in 1995, when the risk of the disease occurring reached 5.9 cases per one thousand of the child population, whereas over 2000–2017, it was no higher than 0.6 cases per one thousand of the child population. In 2012, a close linear relationship between the doses of irradiation of the population and the risk of occurrence of malignant tumours was determined; it was described as an equation: $D = 327.2 - 1.839x$. Mortality of the population in the Zhytomyr Oblast districts which were affected by the Chornobyl nuclear power plant explosion correlates with the parameters of occurrence of the disease. Risk of mortality surpassed the mean level for the Oblast in 2000–2009 in Yemilchenskyi district, during 2000–2009, 2014–2015 in Korostenskyi district, and in 2017 in Narodytskyi; during 2000–2014 in Luhynskyi; and in 2005 and 2016 in Ovrutskyi district. For the assessment of radiological danger, one should take into account amounts of consumption of different products by the population, including the products produced locally. In food products in the territory of all of the studied districts of Zhytomyr Oblast, during 2000–2017, there was observed excess over the acceptable levels of ^{137}Cs activity, and their highest share – in Ovrutskyi and Narodytskyi districts. Within the selected samples of the products, excesses over the accepted levels were observed in 56.9–15.1% of the analyzed samples of forest berries and mushrooms, 13.2–0.8% of samples of cow milk, 5–0.03% of samples of vegetables and potatoes, and 3.0–0.7% of samples of meat. The greatest share of excesses of ^{137}Cs content levels was observed in the products of the forest ecosystems. Values of ^{137}Cs radioactive contamination of certain samples of food products of forest origin surpass the allowable threshold levels by dozens of times, which makes them sources of significant additional internal irradiation. Radiological control of the forest berries and mushrooms, limiting their consumption, culinary processing which contributes to reduction of the activity could allow significant reduction of the radioactive risks for the local population.

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