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Environmental and Hygiene Health Problems in Primorye

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ABSTRACT

Using a systemic approach, this study highlights the problems of public health in the Primorsky Territory and demonstrates that the spread of ecology-related diseases depends on climatic, sanitary, and social factors. The indicators of health assessment that were selected include demographics, cancer and disease, and lung and urinary system diseases. Additionally, specific habitat parameters affecting the spread of ecology-related diseases were established. Ecological and hygiene evaluation of the system "environment–health–man" revealed that among the environmental factors, the greatest public health concerns in the Far East are climate, geochemical and biological features of the territories, consequences of human impact on the environment, nutrition, and housing. These results indicate that further studies of the specifics of particular territories are necessary to explain the emergence and development of diseases, to predict the level of public health, and to develop targeted health prevention programmes to level the influence of environmental factors on human rights.

Introduction

Public health depends on many social, genetic, climatic, and medical factors. The work, daily activity, and relaxation of the population occur in the human environment, which is a holistic system of interconnected components, such as the air, water, soil, flora, fauna, climate, topography, and technological and social spheres that are created by man (Ivanov et al., 2001).

The hypothesis of the existence of links between the environment and human health is generally accepted, and the disease incidence of man is an important indicator of the functioning anthropoecological system. From this perspective, health is a biological indicator of habitat quality. Key consistent patterns determining human health cannot be properly understood outside the population–environmental categories, and are the identification of patterns of interaction with the environment of large groups of people who, because of their social, labour, cultural and biological community, are a population.

It should be emphasised that the idea of the health of the individual and population, although related, belongs to different levels of social organisation. Health is defined as a condition of the body, in which all its functions and manifestations of life are in a harmonious dynamic interaction with the environment (Velichkovsky, 2002a, 2002b). The health status of an individual can be defined as the process of preservation and development of his mental, physical and biological features, and his optimal disability and social activity with

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a maximum duration of active life. This occurs when the entire system adequately responds to the impact of environmental factors (Kiku et al., 2013).

The health states of an individual and population are a derivative of the social and anthropoecological interactions. The health of a population is the socio-historical development of the psycho-physiological and biological viability of the population, succeeded by generations with an increasing pace of social production, and improved stability of the population during the development of new territories (Ivanov et al., 2001). Therefore, along with the health of individuals, it is necessary to distinguish individual indicators that reflect the state of health of the population as a whole.

Health criteria include such demographic indicators, disease incidence, physical development, and disability, which allow for an integrated assessment of the health status of the population of any territory (Gichev, 2004; Medic and Tokmachev, 2006; Lisitsyn, 2010).

The level of population health is a result of the interaction of these and previous generations with the environment, which manifest in various forms under specific conditions of society. Consistent patterns of pathology formation associated with genetic characteristics, basic biological age processes and living conditions are common for the population. Results of a cooperative population-based study conducted in Russia within a single programme showed that the ethnic and population differences, which form a particular epidemiology of the population for the risk of infectious diseases, are primarily mediated by national traditions of food, air quality, local climate, and latitude (Denisov, 2000; Veremchuk et al., 2000; Alekseev and Yanuschenets, 2002; Gichev, 2002; Onishchenko, 2002; Yarygina et al., 2014).

Health and disease categories are largely socially determined. The concept of risk factors is used to address the main issue of medicine, which is what or who directly affects health. The rank scale of risk factors determining the violation of public health is as follows: the image and standards of living, genetic and biological factors, external environment, including the ecology and climatic conditions, and the level and quality of medical care (Lisitsyn, 1998). Lifestyle is a systemic factor of social development and activity and comprises 50–55% of all the factors affecting health. Genetic and hereditary factors comprise 15–20%, and diverse natural, social and technological factors of the environment comprise 20–25%. Health care, including systems, services, and institutions accounts for 8–10%. Lifestyle and exogenous factors play leading roles.

Based on the above, there are four models of disease contraction: ecological, genetic, accumulative (metabolic) and ontogenetic. For these disease categories, diseases are caused by damage because of external and internal factors (Alekseev and Yanuschenets, 2002; Velichkovsky, 2002a, 2002b).

The study of the conditions and environmental factors affecting health and scientific observation of optimal life support systems for conservation and increased reproduction is the point of intersection of anthropic ecological items and medical sciences, and is in the mutual interest for both fields (Konenkov et al., 2003).

Health is a criterion for the operation of an anthropic ecological system, whereas human diseases indicate ecosystem health (Schepin and Tishuk, 2001; Gichev, 2002). The preservation of public health remains a leading challenge for medical, social and integrated management systems worldwide (Declaration of Alma-Ata, 1978; Shevchenko, 2002; Andrews, 2006).

Developing new preventive medicine requires novel theoretical foundations based on medical and environmental perspectives, possibly providing an explanation of causality for human health depending on the habitat.

Medical and Demographic Aspects of Health

The medical and demographic aspects of health in Primorsky Krai are closely related to the socio-economic difficulties experienced in this area and have left an imprint on population processes. The demographic indicators include mortality, fertility, life expectancy, infant mortality rate, the ratio of marriages and divorces. These indicators are crucial for evaluation of the level of living of the population and the degree of development of the country. For the past 20 years in Russia, the mortality has increased by 24%, the birth rate has decreased by 19%, and the natural population growth is negative 6.7 per 1000 people (Velichkovsky, 2006).

The average life expectancy for men is 59 years, and for women it is 72.2 years. Because of the significant differences in mortality, the difference in life expectancy between men and women in Russia is 13.5 years, whereas in Western Europe, it is approximately 7 years. Russia lags behind socio-environmentally developed countries, such as the U.S., Japan, Sweden, England, and Germany in several demographic indicators (Schepin, 2010).

The period between 1991 and 2012 is notable for the intense demographic situation in Primorye. A significant decrease of population occurred in the province. Although the decrease in 1993 was largely stimulated by migration outflow, in 1998–2010, greater than 2/3 of the population decrease was caused by a natural decrease (Kiku et al., 2013).

Over the past 12 years, the mortality rate in the region increased by 32.31% and was 14.34/1000 (in Russia 15.38/1000), whereas the total fertility rate decreased by 37.43% (9.12/1000 — in the region, and 8.71/1000 — in Russia). The main causes of death are cardiovascular diseases (49.10%), injury and poisoning (17.32%), and neoplasms (13.87%). Notably, the structure of mortality has changed in the province such that neoplasms are now the third leading cause of death instead of second. The mortality from diseases has increased significantly by 31.56% for the circulatory system, 49.50% for the digestive system, and 21.00% for trauma.

One indicator characterising the development of society is the sex–age structure. The proportion of persons of retirement age in the province has increased by nearly 18.00%, whereas the number of young people of working age has decreased by 11%. The socio-economic burden of the working population has increased. The state of the society and the quality of life are largely characterised by life expectancy. Over the past 5 years, life expectancy has decreased by 6.20 years for males and by 3.70 years for women, for 53.80 and 68.40 years, respectively. These indicators are below the average national averages.

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Analysis of the primary demographic indicators for 12 years has shown that the highest mortality rate is significantly higher than the province average in the cities Partizansk, Artem, Ussuriysk, Spassk, and Vladivostok and in the Nadezhdensky, Shkotovsky, Spassky, Lesozavodsk, and Anuchinsky districts. The demographic indicators in Artem and Partizansk, where the coal industries are primarily located, are remarkably different from the other cities. The mortality rate exceeds the average in the province by 1.50 times. The demographics in the cities are distinct from the districts. The birth rates in rural areas are 11.41% higher, and the mortality rate and infant mortality are 3% and 10.00% lower, respectively, than in industrial centres.

The state of health and the quality of life are characterised by infant mortality. This indicator is most severe in the Ussuriysk, Partizansk, Dalnegorsk, Arsenyev, Chernigovskaya, Yakovlevsky, Ussuriysky, Korolsky, Oktyabrsky, and Kavalerovsky areas. The increase of infant mortality rate reached 286.00% in the Olginsky area, 149.00% in Fokino, 187.00% in Artem, and 134.00% in Partizansk. The significant increase in the growth rate of infant mortality suggests that there are both demographic and medical problems requiring study and analysis of the health services in these areas.

Analysis of the population health indicators of the province allowed the following:

- Identify a number of negative demographic trends in the province;
- Identify specific areas of socio-economic development in a number of cities and areas of the province;
- Demonstrate that medical and demographic processes are indicators of economic and environmental conditions, and describe environmental, socio-economic, hereditary genetic, medical, and other factors that determine public health.

Characteristics of Respiratory and Genitourinary System Diseases Depending on the Bioclimatic Zones and Biotic Environmental Factors

An important area of public health monitoring is the creation of information-analytical space to obtain risk assessments and epidemiological analysis of the relationship between population health and the environment (Onishchenko, 2005a, 2005b; Reshetnikov, 2013). Assessing the disease incidence of the most common pathologies is important (Revich, 2009; Savchenkov, 2010). Skin, respiratory, digestive, and urinary organs belong to different functional systems. However, the primary role of each functional system is isomorphism, the selective mobilisation of organs and tissues, regardless of their relationship to conventional anatomical systems; therefore, they are a single functional system. The eliminatory system combines several subsystems and has a common final objective to maintain optimal metabolic rate and water–salt balance. Conditions of the skin, and diseases of the lungs, stomach, intestine, and kidney are types of functional integral indicators of the state of the entire excretory system. The compatibility of ecology-related diseases of the excretory system is a primary feature of modern pathology in technologically altered habitats (Kiku et al., 2003a; Velichkovsky, 2003).

Analysis of excretory system morbidity in bioclimatic zones and zones of ecological tension using Pearson matching criteria (chi-square test) revealed a statistically significant correlation ($P \leq 0.001$) between the prevalence of excretory system diseases, bioclimatic zones and zones of ecology for all age groups (Kiku et al., 2003a).

The levels of adult respiratory diseases tend to decrease in the critical ecological zone from the continental bioclimatic zones to the coast, and at the same time, in a relatively favourable zone, a trend from coast to continental bioclimatic zone is observed. Adolescents and children, regardless the ecological zone, show an increase of respiratory system pathology indicators from the mainland biozone to coast. This is largely related to differences in the bioclimate structure of the continental areas and coast in the Primorye Territory (Derkacheva, 2000). During the cold period, optimal, such as mild and moderately severe weather occurs in the continental regions for 50–55 and 40–45 days, respectively, with air temperature from −10.0 to −15.0 °C and light winds. The average degree of functional stress for thermoregulation occurs for 60 days and when air temperatures are between −15.0 and −20.0 °C combined with wind up to 7 m/s, and rarely when the air temperature is −10.0 °C, with strong winds up to 15 m/s. Strong effects on thermoregulatory systems are possible when the temperature decreases to −25.0 °C and the wind speed reaches 7 m/s. On the coast during the cold season, optimal conditions occur when the air temperature does not exceed −10.0 °C in combination with wind up to 7 m/s and high humidity. On the coast, the highly repetitive weather with high relative humidity increases the degree of functional stress for the thermoregulatory systems of the body. Low wind speed in the continental areas of the region leads to the accumulation of plant emissions in a small volume of air, increasing their concentration near pollution sources. On the coast and in the eastern piedmont areas of the province, the wind conditions improve the natural dispersion of pollutants in the atmosphere.

Water is an essential product of biosystem activity. According to the Russian data, 68% of water supplied to the population is water from surface sources and 32% is extracted from underground sources (Onishchenko, 2005a, 2005b, 2007). This is similar for Primorye, except that the percentage of groundwater use is much lower (10%) (Kiku et al., 2003b). In Primorye, approximately 90.00% of the potable surface water undergoes treatment. However, because of the increased pollution of water sources by petroleum products, heavy metals and other harmful contaminants the water purification technologies are not always effective. Noncompliance of water quality with regulatory requirements is primarily caused by the lack of a comprehensive set of facilities for water cleaning and decontamination. In some localities of Primorsky Territory, an exhausted water distribution system and inefficiently chlorinated waters pose a real threat of diseases, particularly of the urinary system (Kiku et al., 2003c). The spread of genitourinary system diseases in adults increases from the continental bioclimatic zones to the coast in all areas. Genitourinary system pathology of adolescents in the transitional biozone has the highest rates in critical and ecologically stressful areas, although a decreasing trend in disease incidence is observed from the continental biozone to the coast. Genitourinary system diseases of children are more common in the transitional biozone in nearly all areas, except for critical areas that show an increasing trend of diseases from the mainland biozone to coast.

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Factor analysis identified the key environmental parameters both for air shed and drinking water supply with the greatest contribution to the formation of each bioclimatic zone. Therefore, the formation of the air basin of the *continental biozone* is affected mainly by the concentration of SO_2, number of clear days, air velocity, precipitation, CO concentration, and temperature. The air shed of the *transitional biozone* is affected by concentration of SO_2, air velocity, humidity, precipitation, fog, clear days, and concentration of solids. The number of clear days, precipitation, air velocity, fog, and temperature are important on the coast.

For the drinking water supply in the continental bio zone, the turbidity, hardness, HCO^{3-}, SO_4^{-2}, Cl^-, Mg^{+2}, $N^+ + K^+$, $Fe^{+2..+3}$, pH, CO_2, dry residue are not significant. In the transitional zone, the Mn, coli-index, hardness, turbidity, $Na^+ + K^+$, $Fe^{+2..+3}$, Mg^{+2}, Ca^{+2}, HCO^{3-}, NO_2^-, pH, CO_2, dry residue, and mineralisation (M) are important. On the coast — hardness, turbidity coli index, Mn, NO_2^-, NO-3 Cl —, HCO^{3-}, SO_4^{-2}, Mg^{+2}, Ca^{+2}, $Na^+ + K^+$, $Fe^{+2..+3}$, salinity, dry residue, and CO_2 are important. The parameters are arranged in order from high to low according to the degree of influence.

Regression analysis (equation of multiple regression) with accounting for the factor analysis results allowed the identification of key biotropic factors that influence the spread of respiratory and urinary diseases in diverse bioclimatic zones. The level of respiratory diseases of children in the continental biozone is affected by fog, SO_2, and average and maximum temperature. For adolescents, these factors include the average temperature, number of clear days, and fog, and for adults, the number of clear days, concentration of solids, and maximum temperature are important. Disease incidence in the transitional biozone is primarily affected by temperature, fog, number of clear days, solid concentration, and humidity for children. The average temperature, fog, SO_2, and CO_2 are important for adolescents, and the concentration of solids, mist, and number of sunny days is important for adults. On the coast, this is influenced by temperature, the number of clear days, and humidity for children. The number of clear days, average temperature, humidity, and NO are important for adolescents, and the minimum and maximum temperatures, SO_2, and fog are important for adults.

Therefore, the spread of respiratory diseases in each age group is dependent on the specific combination of air parameters in the bioclimatic zones. The most significant parameters are temperature factor, concentration of SO_2 and CO_2, and the number of clear days.

Analysis of the water effects on urinary system pathologies showed the following: in the continental biozone, the disease rate of children is affected by Cl^-, NO_3^-, HCO^{3-} Mg, and pH, adolescents are affected by Cl^-, HCO^{3-}, Na + K, and pH, and adults are affected by Cl^- and Mg^{+2}. In the transitional biozone, urinary tract diseases in children are primarily caused by Mt, CO_2, NO_3^-, $Na^+ + K^+$, and $Fe^{+2..+3}$, by Mt, CO_2, $Fe^{+2..+3}$, and $Na^+ + K^+$ in adolescents, and $Fe^{+2..+3}$, Mn, and CO_2 in adults. On the coast, NO_3^-, HCO^{3-}, Ca^{+2}, and Mg^{+2} are important for children, Ca^{+2}, and HCO^{3-} are important for adolescents, and for adults, NO_3^-, HCO^{3-}, Ca^{2+}, and pH are important. The urinary system disease spread rate for each age group is dependent on the chemical composition of drinking water. The primary components are Cl^-, NO_3^-, HCO^{3-}, Mg^{+2}, and pH.

The results of evaluation of biotropic environmental factors are as follows:

- Dissemination of eco-dependent pathology of the excretory systems of Primorye Territory inhabitants depends on the characteristics of the bioclimatic zones and combinations of parameters in these zones;
- The spread of excretory system diseases (respiratory and urinary) in childhood is predominantly affected by bioclimatic factors, including high humidity, temperature changes, movement of air masses, and chemical composition of drinking water;
- Indicators of adolescent morbidity are approaching those of adults, although a high level of respiratory disease is noted, indicating the inability of the teenage body to adapt to adverse environmental factors;
- Incidence and spread of excretory system diseases of Primorye Territory adults are largely because of environmental conditions;
- The level of excretory system pathology in each age category is affected by a specific combination of biotropic environmental factors.

Increased Thyroid Pathologies in the Primorye Territory

Hygienic evaluation of the air and water basins, soil and food in Primorsky Krai shows that the environment determines the distribution of the various diseases. For the regional Primorye sanitary-epidemiological features, the combined effects of natural geochemical (imbalance of micro elements) and anthropogenic environmental contaminants (heavy metals, toxins, pesticides, and harmful impurities) suggest negative trends for the health indicators of population.

The continuing influence of anthropic ecologic stress may lead to the transition of neuroendocrine homeostasis to a new bioenergy level, expressed in the changed state of health to a premorbid state or chronic pathological process. Hormonal changes are common for all adaptive reactions in the body caused by a changing environment. H. Selye in his study on general adaptive response determined a special role for the endocrine system.

The selection of clinical entities as markers of environmental pollution and as easily accessible for both monitoring and accounting is important (Kiku and Geltser, 2004; Rakhmanin and Revazova, 2004; Potapov et al., 2008). Thyroid gland (TG) diseases can assess the negative impact of environmental, particularly geochemical factors (Andryukov et al., 2013). Epidemiological study of various forms of thyroid pathology conducted by a specially designed programme in 10 regions of Russia with different environments from 1982 to 1996 revealed differences in the incidence and progressive increase of thyroid disease depending on the degree of ecological problems in the regions (Shapkina and Kasatkina, 2002).

Functional and morphophysiological thyroid conditions reflect interaction of the thyroid with the environment (Andryukov, 2010). Average volumes of the thyroid of all age groups in Primorye are higher than in other regions with normal iodine content, suggesting a regional feature of thyroid stress. Thyroid hyperplasia is determined by complex climatic, ecological and social factors. A primary aetiology of hyperplasia of Primorye residents may be exogenous and endogenous (secondary) iodine deficiency, as

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evidenced by trace element imbalance. Manganese, cobalt and copper are specific microelements, the increase or decrease of which can cause secondary iodine deficiency (Shapkina and Kasatkina, 2002). The ratio of these microelements with iodine allows the prediction of iodine deficiency diseases.

According to the regional health information-analytical centre, the endocrine system hospitalisation morbidity of adults and adolescents in the Primorye Territory in 1998–2012 increased by 17.8%. This dynamic is inferior only to the diseases of the circulatory system. Thyroid diseases in adolescents associated with iodine deficiency increased by 47.7%. The evaluation of thyroid abnormalities among adults and adolescents, depending on the environment and bioclimatic zones showed that there are differences in the incidence of various clinical entities.

The spread of the diffuse endemic bronchocele among both adults and adolescents is higher in all bioclimatic zones. In the continental and coastal biozones, a high level of thyroid pathology of adults is observed in relatively favourable ecologies, which may be caused by natural factors shaping the geochemical environment. In the transition biozone, anthropogenics of the ecology contributes to the emergence of diffuse bronchocele and subclinical hypothyroidism. In sever ecologies, there is an increase in multinodular endemic goitre.

For adolescents, there is a high level of diffuse goitre that exceeds other clinical entities in all biozones and areas. Unlike adults, the highest level of diffuse goitre in adolescents occurs in the areas with critical environments, particularly in the transitional and coastal bioclimatic zones. This suggests that under the strong influence of adverse environmental factors, the breakdown of mechanisms of adaptation occurs, which is manifested in the thyroid gland. High levels of subclinical hypothyroidism in these zones are also notable. Critical ecological conditions are representative only for the industrial centres of the Primorsky Territory, part of which is located on the coast; therefore, thyroid disease is ecology dependent and an indicator of the urban habitat. Notably, multinodular endemic goitre and subclinical hypothyreosis in some areas are not identified as mechanisms of genetic interference.

The assessment reveals that climatic and sanitary and environmental factors in Primorsky Krai significantly impact the spread of thyroid pathology among adults and adolescents. This must be considered when conducting public health monitoring and for the development of therapeutic and preventive measures related to iodine deficiency.

The Spread of Oncology-Related Diseases Depending on Environmental Stress

The second half of the 20th century was characterised by rapid growth of malignant tumours in worldwide population. This is associated with a qualitative change in the environment (Remennik and Starinskiy, 2000; Trapeznikov and Axel, 2000; Zaridze, 2000; Howe, 2006; Kiku et al., 2012). Among the risk factors of malignancy development are adverse lifestyle factors (45.00%), environment pollution (19.00%), and genetic risk (26.00%) (IARC Monographs on the Evaluation of Cancirogenic Risk to Humans, 2002; Chissov et al., 2007).

According to several authors, greater than 80–90% of malignant tumours result from external factors (Smulevich, 2003; Roe, 2004). The uneven spread of cancer diseases in different regions and the change in incidence of migration conclusively establish the link between cancer and ecological features of human existence (Stern, 2003; Russo and Franceschi, 2006; Schraub, 2009).

Onco-epidemiological studies identified the role of environmental factors on tumorigenesis. According to the WHO Committee on cancer prevention, up to 90.00% of tumours are associated with environmental factors, and the remaining 10% are caused by viral, genetic and other endogenous factors (Higginson, 2005). The results of onco-epidemiology studies indicate that the carcinogenic environmental factors and lifestyle cause 90–95% of malignant tumours (Zaridze, 2000; Longnecker, 2005; Kelsey and Bernstein, 2006).

Based on system studies of the multifactorial effects of the environment on the prevalence of cancer, the integral impact index was calculated to characterise the state of the environment using socio-hygienic, anthropogenic and medical geographical modules, both together and separately (Yudin et al., 2002). The influence and relationship of environmental factors and indicators of incidence, morbidity and mortality from malignant diseases were determined.

For ecological and medical propagation analysis of cancer incidence in the province, an algorithm based on environmental factors was used (Yudin et al., 2002). Initially, the study focused on the influence of the environment on all nosological (localisation) cancer pathology in the Primorye Territory. Furthermore, the number of investigated clinical entities was narrowed to 6, stomach cancer, colon cancer, lung cancer, bladder cancer, skin tumours, and haematological malignancies. The correlation coefficient of environmental influences on cancer pathology was the selection criterion for oncopathology locations. Nosological forms, with correlation coefficient ranging from 0.75 to 0.95, were selected for further in-depth analysis in the "environmental factors–oncopathology" system.

The first stage was the evaluation of proliferation of cancer incidence depending on the environment. The connection between the main forms of cancer incidence with the ecological zones is apparent. There is also a direct correlation between the zones of ecological stress and the morbidity of lung and stomach cancer, skin tumours, colorectal cancer, and onco-urological pathology, including bladder and kidney cancer (Kiku et al., 2002a). However, the correlation of the environmental influences and the distribution of tumour locations, such as breast cancer, ovarian cancer, and cervical cancer were not identified.

A high prevalence of cancer pathology is observed in areas of critical and stressful environmental conditions, where the coal industry, mining and chemical industry, ship repair, construction, engineering industries and areas with intense chemicalisation and lack of agriculture are located. These cities are Artem, Spassk, Vladivostok, Dalnegorsk, and Ussuriysk and the districts are Spassky, Dalnegorsky, Kavalerovsky, Shkotovsky, Korolsky, Chernigovskaya, and Khankaisky. These cities and districts have more than half the major manufacturing plants for 1 and 2 classes of hazards, and exceed the maximum permissible concentration (MPC) of harmful substances in the air, soil, and water in these areas by as much as ten-fold levels.

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The most common nosological form of lung cancer depends on anthropogenic factors for incidence, morbidity and mortality. The dependence is maintained in the cities, regions and Primorye overall (Kiku et al., 2002b).

Regression analysis of the impact of environmental factors on the oncological pathology of the population of Primorye Territory indicates that soil is the principal cause of mortality, morbidity and incidence for the regional ecosystem zones. In the regional ecosystem, the oncologic conditions for mortality, morbidity and incidence are determined by the air pollution.

In severe ecological zones of the cities, the oncological conditions for mortality and morbidity are based on chemical pollution and adverse physical factors. In the intense regional ecological zone, the oncological conditions for incidence and morbidity are determined by natural forest cover.

The prevalence of gastric cancer in Primorye Territory is determined by the soil and hygienic characteristics of food raw materials and food products. The greatest effect of these factors is in the critical zone of the regional ecosystem in relation to incidence, morbidity and mortality.

In the cities of Primorye Territory, a tense ecosystem zone, the incidence of gastric cancer depends on the social infrastructure and hygienic characteristics of food raw materials and food products of both domestic and foreign production. Morbidity and mortality are determined by the following factors: drinking water supply and condition of bodies of water where water is used and the nature of soils. In the province districts in the tense ecological zone, the incidence of gastric cancer indicator is caused by the soil and nature of the vegetation cover. Morbidity and mortality from gastric cancer are determined by the utility and drinking water system, bodies of water, water management and type of soils.

The influence of environmental factors on lung cancer is clearly demonstrated. In the critical zone of the regional ecosystem, the incidence of lung cancer is affected by the air pollution and social structure of the territory. Morbidity from lung cancer in this area is determined by chemical pollution and adverse physical factors.

In cities of the tense ecological zone, the incidence of lung cancer is due to soil condition factor, and morbidity is affected by the social structure of the territory and the presence of companies according to hazard classes. In province districts of the tense ecosystem zones, the prevalence of lung cancer is determined by the soil condition, chemical pollution and adverse physical factors in urban and rural settlements.

The onco-pathology in cities is affected more by the anthropogenic impact on the environment and the social infrastructure. The impact of the natural environment factors is notable in the districts.

The index of integral action (IIA) was calculated and determines the response of the organism to environmental impacts. Five blocks of integral action are distinguished about 43 environmental factors (Kiku et al., 2002c). The purpose was to analyse the impact of factor complexes on the onco-pathology. Grouped factors were correlated with cancer pathology, including the incidence (revealed for the first time), morbidity and mortality.

To calculate the weight values of the environmental risk factors that influence malignant diseases, an information-entropy analysis was performed with the grouped data of the environmental factors and incidence, morbidity and mortality indicators. The analysis revealed that in the Primorye Territory, the influence of anthropogenic factors on the overall incidence (42.7%), level of morbidity (48.80%) and mortality (36.91%) is significantly higher than the influence of socio-hygienic factors (27.70%, 26.14% and 30.13%, respectively) and climatic factors (29.60%, 25.12% and 33.00%, respectively). In the cities, the influence of anthropogenic factors on the incidence (52.85%), level of pain (54.00%) and mortality (55.32%) is significantly higher than the socio-hygienic factors (respectively: 33.00% 34.62% and 33.71%, respectively). Common nosological forms of cancer pathology (lung cancer) depend on anthropogenic factors (impact on incidence in the cities: 56.30%, in districts: 21.50%). There is a significant degree of influence of anthropogenic and socio-hygienic factors on the formation of malignant colon cancer, skin cancer, and urinary organ cancer.

There are a variety of environmental factors affecting the overall cancer incidence in Primorye. The anthropogenic factors affect the cancer incidence in the cities of Arsenyev, Vladivostok, Spassk-Dalny, and Dalnegorsk and the districts of Nadezhdensky, Kavalerovsky, Khankaisky, and Chernigovsky. Socio-hygienic factors determine the cancer pathology in the cities Dalnegorsk, Artem, Partizansk, and Ussuriysk, and districts Olginsky, Partizansky, Mikhailovsky, and Khorol. The hydrosphere and other climatic factors affect the prevalence of cancer in Nakhodka, Dalnegorsk, Dalnerechensk, Lesozavodsk, and Bolshoy Kamen and the Terneisky, Krasnoarmeisky, and Mikhailovsky districts.

Using information-entropy analysis, the cause–effect relationships were identified in the system "habitat–onco-pathology" to establish the basic patterns of distribution of malignant neoplasms in the Primorye Territory under the influence of environmental factors, thereby forecasting the cancer incidence for following years (Kiku et al., 2003c).

Summarising the environmental and hygienic system "Environment–man–health" in the Far Eastern region, the most significant environmental factors for public health are climate, geochemical and biological features of the territories, results of human impact on the environment, nutrition, dwellings and others. Biotropism of geochemical features in the Far East has not been sufficiently studied, nevertheless there is data identifying the provinces with iodine and selenium deficits, territories with extremely hard water, with water and soil containing heavy metal salts and other components. Multidisciplinary studies showed that for demographic indicators of the spread of ecology dependent diseases (diseases of the respiratory and urinary tract, skin neoplasms, and thyroid disease), organism resistance serves as an indicator of the environmental and health conditions. Continuing the assessment of health and the complex influence of environmental factors, it is necessary to study adaptation, reserves of the body and the immune system, non-specific defence, and reaction to environmental factors on the population, organism, organ, cellular and subcellular levels. This allows a systematic characterisation of population and individual health.

These results indicate the need for further studies of the specifics of particular territories to explain the emergence and formation of diseases, predict public health and develop target health prevention programmes to level the influence of environmental factors on humans.

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