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Contact Information:
82 Monastyrskaya St.,
Perm, 614045, Russia
Tel/Fax: +7 (342) 237-25-34
E-mail: journal@fcrisk.ru
Site: journal.fcrisk.ru/eng

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SOCIAL AND HYGIENIC MONITORING TODAY: STATE AND PROSPECTS IN CONJUNCTION WITH THE RISK-BASED SUPERVISION

N.V. Zaitseva [1,2], I.V. May[1], D.A. Kiryanov[1], D.V. Goryaev[3], S.V. Kleyn[4]

[1]Federal Scientific Center for Medical and Preventive Health Risk Management Technologies, 82 Monastyrskaya Str., Perm, 614045, Russian Federation
[2]Perm State Medical University named after E.A. Wagner, 26 Petropavlovskaya Str., Perm, 614000, Russian Federation
[3]Administration of the Federal Supervision Service for Consumer's Rights Protection and Human Welfare in the Krasnoyarsk Region, 21 Karatanova Str., Krasnoyarsk, 660049, Russian Federation
[4] Perm State National Research University, 15 Bukireva Str., Perm, 614990, Russian Federation

It is shown in the article that since the establishment in 1992 and until now the social and health monitoring (SHM) operates as a complex open system of extended collection and processing of heterogeneous data about the parameters of the environment, socio-economic indicators of living of the population of the country's regions, medical and demographic characteristics of society as a whole and of individual population groups. As part of the SHM system Rospotrebnadzor annually performs hundreds of thousands of instrumental measurements of objects in the environment of the Russian Federation. These federal and regional information assets have tremendous analytical capacity and allow a knowledge-based processing of information in the "health-environment" system for a variety of management tasks of sanitary and epidemiological situation.

Changing of the general paradigm of control and supervisory activities of Rospotrebnadzor and giving a fundamentally new status of control measures to researches and measurements of the system of social and hygienic monitoring without interaction with legal entities and individual entrepreneurs were important bases for further improvement of the SHM. The development of SHM in conjunction with the risk-based supervision model can significantly improve analytical capabilities, effectiveness and efficiency of each system. This development requires the adoption of a new edition of The statements of the SHM, the development of a scientific approach to the formation of "risk profiles" of objects of sanitary and epidemiological surveillance; the development of methodological approaches to the selection of points and formation of programs of instrumental studies of air, water and soil as the control activities in the areas of influence of economic entities. Of great current interest are the development and consolidation of regulatory requirements for the registration of the results of sampling and measurement in the course of monitoring activities in the framework of the SHM; the establishment of criteria for associating violations of hygienic standards of air quality, natural and drinking water and soil with the facts of causing threat to life and health of citizens; the development of scientific and organizational approaches

Nina V. Zaitseva – Member of RAS, Doctor of Medical Sciences, Professor, Director (e-mail: znv@fcrisk.ru;
tel.: +7 (342) 233-11-25).

Irina V. May – Doctor of Biological Sciences, Professor, Deputy Director for Research (e-mail: may@fcrisk.ru;
tel.: +7 (342) 237-25-47).

Dmitry A. Kiryanov – PhD in Engineering, head of the department of mathematical modeling of systems and processes (e-mail: kda@fcrisk.ru; tel.: +7 (342) 237-18-04)

Dmitriy V. Goryaev – director, chief state sanitary doctor of the Krasnoyarsk Region (e-mail: goryaev_dv@24.rospotrebnadzor.ru; tel.: +7 (391) 226-89-50).

Svetlana V. Kleyn – Candidate of Medical Science, Associate Professor of Human Ecology and Life Safety (e-mail: kleyn@fcrisk.ru; tel.: +7 (342) 237-18-04).

to the establishment, registration and proof of cases of harm to human health in violation of the mandatory requirements of the objects of sanitary and epidemiological surveillance.

***Key words**: socio-hygienic monitoring, control and surveillance activities, sanitary-epidemiological well-being.*

Socio-hygienic monitoring as a state system for surveillance over public health and environment, analysis, assessment and prognosis, as well as evaluation of cause-effect relationship between the population health and environmental factors impact, is implemented by the bodies and organizations of Rospotrebnadzor (Federal Service for Surveillance over Consumer rights protection and human well-being) for over 20 years.

Established in 1994[1] and being developed consistently with the federal[2,3] documents and Rospotrebnadzor[4,5,6,7] regulations, the social and hygienic monitoring was aimed at accumulating data to evaluate the cause-effect relationship between the Russians health and the impact factors thereto, and performing deep high-tech analytical tasks for the benefit of the decision-makers at various federal levels.

Starting from its foundation and up to date, SHM functions as a complex open system for an ongoing collection and processing various data on the environment parameters, socio-economic indices of the country's regions, medical and demographic characteristics of the society as a whole and of individual population segments[8].

No any other state monitoring system in the Russian Federation is such interdepartmental by its type and focused on the collection and processing of such diverse information. As part of SHM system activities, Rospotrebnadzor has been carrying out instrumental measurements in all the subjects of the Russian Federation since 1994. Over 2015 only, the ambient air measurements were taken at 2290 monitoring points and observation posts (over 1,350 thousand air samples were studied); measurements of centralized drinking water supply systems indicators: at 11,145 monitoring points; soil measurements: at 8,165 monitoring points [17]. The number of monitoring points and scope of measurements in the previous years were even larger. The extensive and dynamic information

reflects the habitat state of almost the entire population of the country.

The task of structuring, accumulation and annual cross-spectrum analysis of the data in a single system of the federal information fund required efforts of all structural divisions within Rospotrebnadzor in the regions, departmental research institutions, central office, Federal Center for Hygiene and Epidemiology. Major efforts have been made to establishing and keeping the inter-agency arrangements and the procedure of interaction [1,7, 9].

Information being collected in SHM, of course, has a number of shortcomings that should be addressed and revised. The system requires strict initial control of the data re-

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[1] RF Government Decree of 06.10.1994, No. 1146 "On Approval of socio -hygienic monitoring".

[2] RF Government Decree of No. 426 of June, 1, 2000. "On Approval of provisions on socio -hygienic monitoring".

[3] RF Government Decree of 02.02.2006 No. 60 " On Approval of provisions on implementation of socio -hygienic monitoring".

[4] Order of the Federal Service for Surveillance over Consumer Rights Protection and Human Wellbeing of 30.12.2005, No. 810 "On the list of indices and data for establishment of the Federal Information Fund of socio -hygienic monitoring"

[5] Order of the Federal Service for Surveillance over Consumer Rights Protection and Human Wellbeing of 07.02.2007 No. 33 "On Amendments to the procedure for socio-hygienic monitoring, data reporting and sharing"

[6] Order of the Federal Service for Surveillance over Consumer Rights Protection and Human Wellbeing of January, 31st, 2008, No. 35 "On criteria for determining the baseline minimum level for arranging and execution of socio-hygienic monitoring"

[7] Order of the Federal Service for Surveillance over Consumer Rights Protection and Human Wellbeing of March, 3rd, 2008, No. 69 "On action-plan to further improvement of social and hygienic monitoring"

[8] Order of socio-hygienic monitoring execution, data reporting and sharing between federal executive bodies, institutions and other organizations involved in socio-hygienic monitoring. Approved by the Ch. Public Health State Officer Order. ddt. 17.11.2006 No. 37.

ceived from the regions [16,19]. At the same time, federal and regional information funds data accumulated for over more than 20 years are in many respects unified in structure and collection procedure, have enormous analytical capacity and allow for knowledge-based processing of the information within "health-environment" system for a variety of tasks in controlling the sanitary and epidemiological situation. And there are numerous examples thereto. Everywhere SHM data are used for the integrated hygienic assessment of the regions [1,4,6,11,19]. Publications by the experts from Sverdlovsk, Kaliningrad, Voronezh and Lipetsk regions, the Republic of Tatarstan, a number of other regions show that the information on negative effects of environment quality towards population health are the basis for the regional action-plans in the field of sanitary and epidemiological welfare of the population [22,26,28,29]. In St. Petersburg, Moscow, Irkutsk regions, SHM results were used in urban development and spatial planning [3,10,13]. The results of implementing the socio-hygienic monitoring data for the management tasks in a number of lifestyle factors have been published [9]. The regions gain experience in cross-spectrum analysis of the official statistical reporting forms data and primary materials on the population health indices [19].

According to the results of socio-hygienic monitoring, about 3,500 management decisions are taken throughout the country every year [17]. These are the decisions realized as the actions within the framework of the regional dedicated programs for the prevention of mass non-infectious diseases due to environmental factors and individual hygiene and sanitation, health-care and other activities.

It should be noted that the system initially allowed for functional development. The strongest progressive movement in SHM since its launch has been the use of health risk assessment methodology at exposure to environmental hazards. The latter was supported by the approved Regulation "On the use of risk assessment methodology for managing environmental quality and population health in the Russian Federation"[9]. This document, strategic in nature, led to a series of effective practical steps to substantially enhance the analytical capabilities of monitoring. The risk assessment methodology allowed new approaches to evaluating the links in "environment-health" system and identifying the
causes and conditions of health disorders. Now we can structure the risks, assess the contribution of individual factors in the overall risk and prioritize them; define the localities (zones, areas) of the highest level risks to health, and on the contrary, the most favored localities; forecast negative or positive shifts in the population health by analyzing trends in habitat quality [1,12,18]. There have appeared works developing and completing the traditional approaches to assessment of chemical risks and allowing for assessment of the health risks at exposure to chemical, as well as to a number of physical factors: noise, electromagnetic radiation, lifestyle factors, etc., using a single methodological approach thereto. [14].

Risk assessment in many ways did even "replace" the targeted epidemiological studies in the regions. Based on the assessment of health risks within SHM, decisions are taken to decrease pollution, optimal diets are developed, rehabilitation and preventive care measures for unacceptable risk areas are implemented, proposals for optimizing supervisory activities are introduced [8, 12, 20, 21, 25, 30, 31]. Risk assessment is seen as an es-

[9] *Regulation "*On the use of risk assessment methodology for managing environmental quality and population health in the Russian Federation" *Approved by the Ch. Public Health State Officer of Russia No. 25 of 10.11.1997; Ch. State Inspector on Environment Protection of Russia No. 03-19/24-3483 of 10.11.1997*

[10] *Federal Law No. 294-FZ "On protection of the legal entities and individual entrepreneurs rights in the exercise of state control (surveillance) and municipal control" as amended on 07.03.2016, (Article 8.1. Use of risk-based approach in the organization of state control (surveillance) (introduced with the FederalLlaw of 13.07.2015 No. 246-FZ)*

[11] *Federal Law of June, 29th, 2016, No. 277- FZ "On amendments to the Federal Law "On protection of the legal entities and individual entrepreneurs rights in the exercise of state control (surveillance) and municipal control" and Federal Law "On strategic planning in the Russian Federation".*

sential component in forming the basis for evidence of harm to human health [9].

Introducing new approaches in SHM practice has greatly affected also the demand for the outcomes of the system. Based on materials of Ivanenko et al. [23], SHM system improvement and annual reports of the observations on the state of environment and health of the people living in the capital implied positive medical and demographic trends, clear stabilization or decline in morbidity, authentically associated with environmental risk factors, reduced incidence of life-threatening diseases (perinatal pathology and congenital malformations, reduced the incidence of foodborne diseases related to social factors). Thus, according to Kuzmin S.V. et al. [27], using the risk assessment and management methodology in Sverdlovsk region led to an over three-times increase in the number of management decisions taken by the executive authorities and aimed at ensuring sanitary and epidemiological welfare of the population. The number of consumer rights violations resolved through the pre-trial process increased in 1.3 times, the proportion of Rospotrebnadzor claims satisfied on behalf of the groups of persons increased by 1.2 times.

It's no doubt the system of social and hygienic monitoring has wide prospects for further development. Geo-information technologies are in progress, which, based on vector maps of localities and using high-end software, allow for integration of the diverse, geographically-dispersed data and generation of the fundamentally new information visualized also in a well-understood forms of evidence [12,13,24]. The biological monitoring methods, which have every reason to be included in the overall SHM structure, are being developed [5,15,32,33].

However, the major grounds for "reformatting" SHM is shifting the overall paradigm of Rospotrebnadzor control and supervisory activities towards risk-based model[10] and giving the research and measurements within socio-hygienic monitoring system an entirely new status of control activities without legal entities and individual entrepreneurs[11] involved.

Obviously, search and legislative consolidation of the new forms and instruments of control in the country is realized as part of the surveillance activities reform on the whole, the purpose thereof is to reduce total administrative burden on business. This assumes a strong focus of the supervisory authorities in the high-risk areas and excluding the objects of low-risk to the values under state protection from the routine monitoring. At the same time, the first steps towards implementation of the risk-based model have already been made: categorization of sanitary and epidemiological surveillance objects by risk of harm to health, when planning the activities for 2017, showed that about 36% objects can be categorized as low-risk objects and excluded from the routine surveillance.

However, the state control liberalization should not result in a loss of controllability of the sanitary-epidemiological situation by Rospotrebnadzor bodies. And one of the means to prevent such losses is a beneficial convergence of the control and surveillance activities system and socio-hygienic monitoring.

Pairing the two functions and systems of Rospotrebnadzor is fairly harmonious and reasonable. Since SHM initially was targeted mostly on establishing the measures to eliminate harmful environmental effect on the population, it's obvious that these measurements and research should be focused mostly on the harmful factors affected areas. In this case, the vital task of the current phase is a scientific and methodological rationale for the selection of monitoring points and creating the programs using the research tools for studying

[12] *RF Government Decree of 17.08.2016, No. 806 "On use of risk-oriented approach to organization of certain types of state control (surveillance) and amendments to certain acts of the Russian Federation Government" (together with the "Terms of reference for legal entities and individual entrepreneurs activities and (or) for the production facilities they use to a certain risk category or a particular class (category) of hazard"*

ambient air, natural, drinking waters and soils in the affected areas of the objects of extremely high, high and significant risk to health.

The choice of points and research programs must provide for reliable evidence and results, including the indicators of:

- threat of harm to human life and health;
- objects forming threat of harm to life and health (if such threat exists).

The above statement of the task requires the social and hygienic monitoring both to realize its original function on forming the evidence of causal relationships in the "health-environment" system, as well as to implement new function on establishing the source of threat. Taking into account that sources of threats are primarily the objects of sanitary-epidemiological control, the convergence of SHM and its control and surveillance activities is getting urgent obviously.

The principal diagram of convergence for the system of socio-hygienic monitoring and the risk-oriented control and surveillance is shown in Figure 1.

Pairing SHM and control & surveillance activities is implemented by the consistent steps:

- introducing the register of legal entities and individual entrepreneurs subject to surveillance;
- assessment, per each object under surveillance, of the potential risks of harm to health for the tasks of categorization (classification) and planning the surveillance activities[12];
- selection of the objects to be classified as of very high and high risk to public health in the region;
- geographical reference of these objects to localities;
- rationale for the "risk profiles" of the objects under surveillance, i.e. a system of indices characterizing the priority factors contributing to overall risk level of an object, and their inter-relationships;
- convergence of the object level of risk to health and the regional demographic indices, selecting localities of the highest mortality and morbidity share associated with the risk generated by the objects under surveillance due to violations of sanitary legislation.
- establishing SHM programs considering the following requirements: monitoring point is located in the area of the highest potential risk of harm to health by the object under surveillance in violation of sanitary legislation and the highest mortality and morbidity associated with the negative factor; monitoring program aims to measure the factors that generate the highest risks to health; monitoring program includes a sufficient minimum number of observations for the next analytical processing.

Outcome analysis of the control and surveillance activities is carried out in convergence with SHM results. If SHM results showed the levels of environment pollution hazardous to human health, the crucial task then is to revise the control & surveillance activities in relation to the objects that can be a source of this pollution.

The given approach best corresponds to the control and surveillance activities focus on the end-result: preservation of public health. However, the new challenges significantly upgrade the requirements for each element of the socio-hygienic monitoring and risk-oriented model of the control & surveillance service.

Requirements for the registers quality of the objects under sanitary and epidemiological surveillance, for correctness and transparency in evaluating the category of the object by the risk of harm to health are upgraded.

It appears a task of creating the risk "profiles" and selecting the specific risk-induced factors of chemical, biological, physical nature, which should be measured.

It’s increasing the demand for situational modeling tools, including GIS-based platforms.

It is becoming urgent the development of scientific and methodological basis of records, evidence, registration of cases of harm to human life and health due to violations of sanitary legislation, confirmed by SHM measurements. At the same time, Rospotrebnadzor bodies and organizations in many respects are ready to innovative changes.

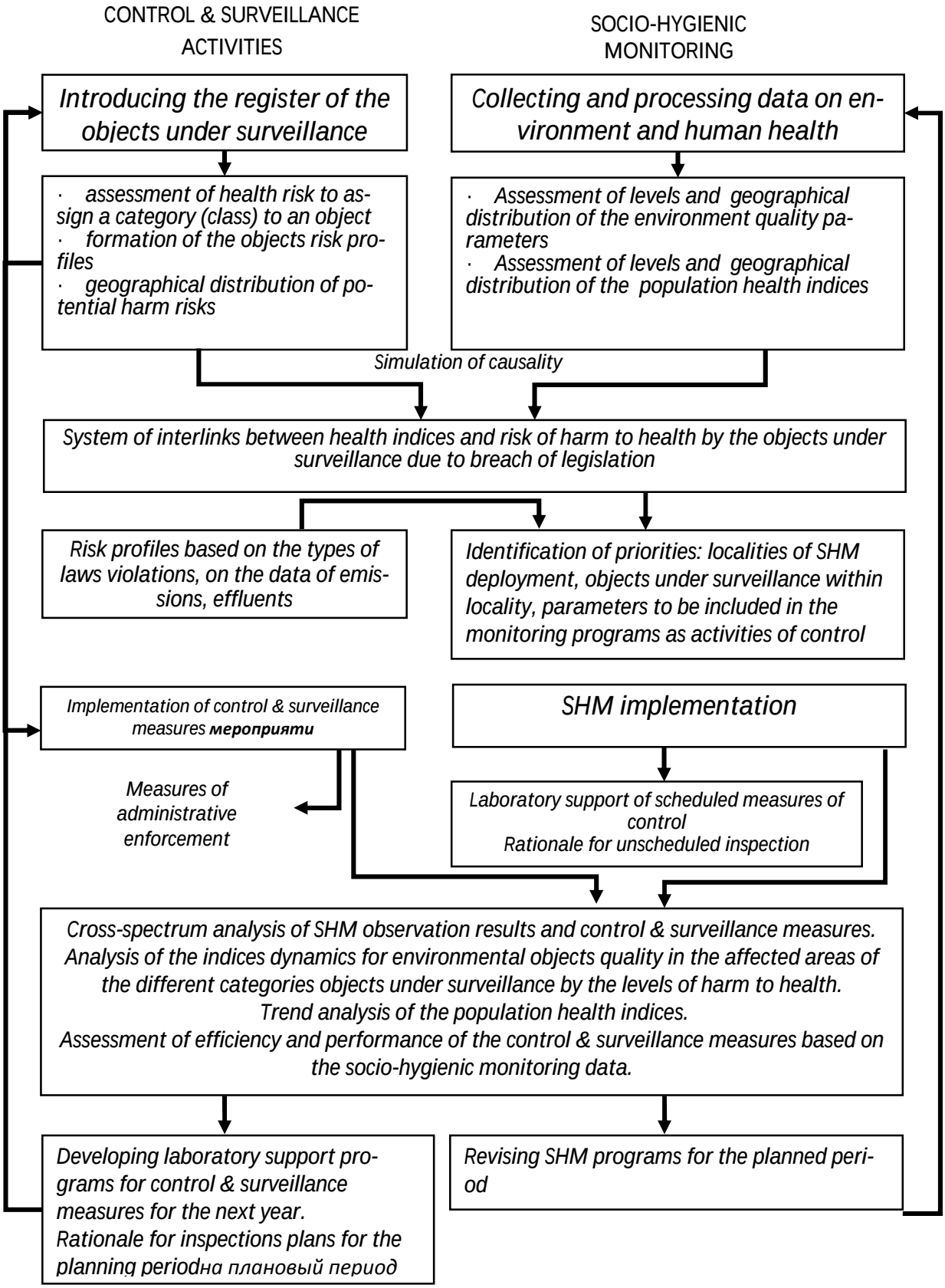

Fig.1. Conceptual diagram of data integration in environment and health monitoring and control & surveillance activities

In the example of the Krasnoyarsk region, in order to develop and improve the system of SHM together with the risk-oriented surveillance, the first few steps are taken:

- the register of objects under surveillance is made (about 57 thousand objects, affecting the quality of air, water, soil, climate, etc.);

- the classification of objects under surveillance is made upon the assessment results of the risk of harm due to violations of sanitary legislation in the established procedure;

- all the objects under surveillance in ARCGIS (version 9.0) are linked to the vector map of the region and the municipality area at the place of actual location;

- the total potential risks of harm to health, being generated as a result of violations in the sanitary legislation mandatory requirements by the objects under surveillance in the Krasnoyarsk region, have been evaluated per each municipality (please, see the example, Fig. 2);

- the scope of instrumental and other studies under SHM have been analyzed per each area (please, see the example, Fig. 3).

It's found that the demographic and health parameters data are sufficient for further in-depth analysis of the cause-and-effect relationships in the "health-environment" system, while the environmental factors data are not always adequate to the potential risks.

If high risks in the localities of Norilsk, Divnogorosk, Sosnovoborsk are secured with the adequately intensive monitoring system, the high risk of harm to health in the cities of Kansk, Sharypovo, Nazarovo, Achinsk, of Birilyussy area, etc. require complex observation over the risk factors. A high level of SHM intensity in Minusinsk does not correspond to the relevant threats and hazards level that indicates the possibility to redistribute instrumental studies within SHM. Thus, the first reconnoitring steps already allow identify the main areas of SHM system optimization at the regional level.

In future, SHM optimization assumes:

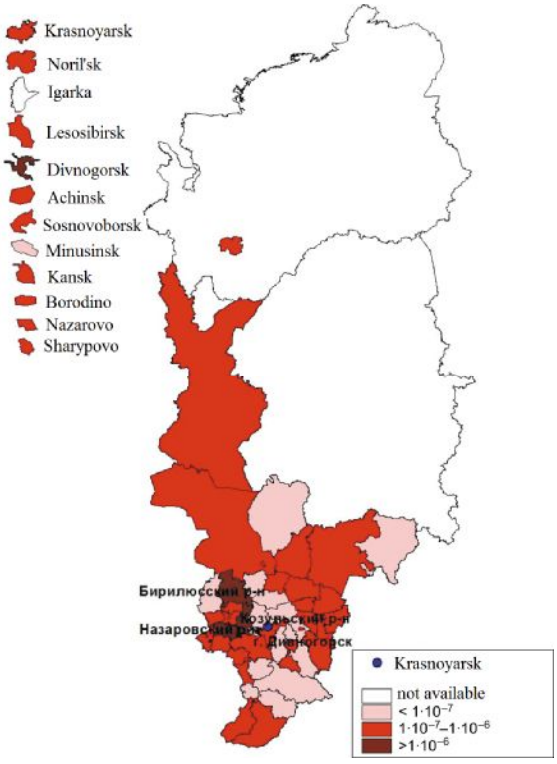

Fig. 2 Total potential risk of harm to public health due to violations in the sanitary legislation mandatory requirements by the objects under surveillance in the Krasnoyarsk region

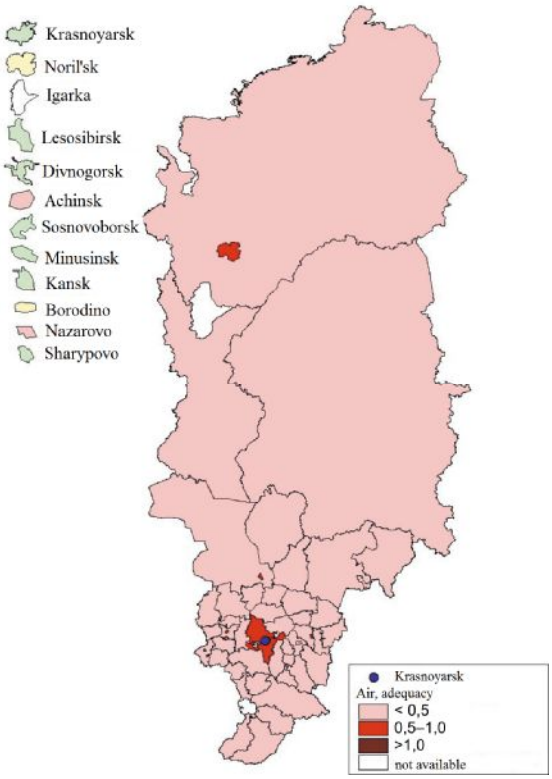

Fig. 3 Ratio of the indices measured to the number of influencing factors

- an estimation of mortality and morbidity share in the population of the region's municipalities formed by the potential environmental risks;

- a selection, per each priority area, of the affected zones by the objects of extremely high and high risk of harm to public health;

- an analysis of the priority risk-generating factors (in this case, a set of risk factors can be quite individual for each area)

Upon the outcomes of SHM and control and surveillance activities, it is expected not only to reveal (confirm) causal relationships in the system "risk factors - environment quality - public health", but also to perform a cross-spectrum analysis of "Rospotrebnadzor actions - environment quality - public health". The latter will allow eventually to assess the performance and efficiency of the control and surveillance activities, as well as to develop a series of recommendations for the third-party stakeholders in the control process over the environment and population health, i.e. the municipal authorities, enterprises, organizations, and civil society.

Thus, the development of social and hygienic monitoring system together with the risk-oriented model of control and surveillance activities can enhance significantly the analytical capabilities and efficiency of each system. However, such a development requires as soon as possible to:

- approve the new edition of the Regulation on SHM in view of the Federal Law dated June, 29th, 2016 No. 277- FZ "On Amendments to the Federal Law "On protection of rights of legal entities and individual entrepreneurs in the exercise of state control (surveillance) and municipal control" and the Federal law "On the strategic planning in the Russian Federation".

- develop a scientific approach to the "risk profiles" for the objects under sanitary-epidemiological surveillance due to violations of sanitary legislation;

- develop and document methodical approaches to choosing the monitoring points and creating the instrumental programs for studying ambient air, natural, drinking waters and soils in the affected areas of the objects of extremely high, high and significant risk to health, as the measures of control, without legal entities and individual entrepreneurs involved;

- develop and formalize regulatory requirements for sampling and measurements results registration in the course of monitoring activities without legal entities and individual entrepreneurs involved;

- establish criteria for classifying the violations of hygienic standards for the air, natural and drinking water, and soil quality in respect to the facts of causing threat to life and health of the citizens;

- develop scientific and institutional approaches to establishment, evidence and registration of cases of harm to human health at violations in the sanitary legislation mandatory requirements by the objects under sanitary and epidemiological surveillance.

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THE IMPACT OF METEO-FACTORS ON INCREASE OF ARTERIAL BLOOD PRESSURE

V.A. Belyayeva

Institute of Biomedical Investigations, 47 Pushkinskaya Str., Vladikavkaz, 362019, Russian Federation

The aim of the work is to study the impact of the meteorologic factors on the increase of the arterial blood pressure in the population of Vladikavkaz city considering gender specificity. The archive data of the Vladikavkaz ambulance during the first half-year of 2012 were the material of the study, ranged according to the number of calls of the patients with the complaints on the aggravation of symptoms due to the arterial pressure increase. According to the archive data, the corresponding base of average daily indices of meteo-factors (the air temperature, atmospheric pressure, relative humidity, wind rate, cloudiness) was formed, the indices of weather pathogenicity were considered. The posthoc analysis of the obtained data was carried out with the use of the statistical analysis packet Statistica 6.0. It is indicated, that the number of the ambulance calls to the patients with the arterial hypertension increases during "acute" meteo-conditions. The number of calls in women is higher than the number of calls in men. The inverse correlation between average daily air temperature and patients asking for help in the connection with aggravation symptoms against a background of the arterial pressure increase (AP) was revealed. The peak increase of the ambulance calls frequency is observed while low temperature (< – 100 °C). A correlational link between AP increase frequency and the pathogenicity temperature index was established. AP increase frequency correlates with common pathogenicity index in women, and it may point out the high reactivity of cardio-vascular system in response to the impact of complex negative meteo-factors. The impact of the unfavorable weather conditions is the risk factor to the health as it may lead to the development of the cardiovascular catastrophe against a background of AP increase.

***Key words**: arterial pressure posthoc analysis, meteorologic factors, air temperature, pathogenicity index, «irritative» meteo conditions.*

Introduction. The natural human habitat is the Earth's atmosphere, where different physical processes continuously take place, and affect human body, being an open dissipative system. Numerous studies show the interrelation between various failures in human activity, morbidity, death incidence due to the changes in weather, solar activity, with a focus on rapid and aperiodic fluctuations in environmental factors [17, 19, 7]. Climate changes happening in the world represent critical risk factors for human health. Exposure to heat and cold waves for human health in different countries results in increasing the number of climate-related infectious diseases and their spreading to the north, as well as losses in the number of population as a result of exposure to abnormal temperatures [18, 15, 13, 14, 20].

Different atmospheric phenomena represent a stress-factor for healthy individuals, as well as precipitate exacerbation of the pre-existing pathologies [6, 9, 12]. In people with chronic diseases, any fluctuations in the air temperature, atmospheric pressure, electromagnetic field intensity can result in meteorotropic reactions in the form of exacerbation of

Viktoriya A. Belyayeva – candidate of biology, researcher at the Department of new medical technology and regenerative medicine (e-mail: pursh@inbox.ru; tel.: +7 (867) 253-96-29).

the prior disease. Cardiovascular system is the most affected by meteorological factors [1, 3, 8]. Among the markers of meteorological factors that have predominant effect on the human body and increase hypertensic crisis incidence are: cloudy weather with fog and precipitation, sharp drop in temperature and increase in relative humidity, atmospheric pressure variations, dew point [10, 16, 5]. It is known that the formation of cyclones with severe frontal sections and ascending air currents, accompanied by disrupting diurnal variation of the main meteorological factors, predispose destabilization of blood pressure [4]. The problem of human meteosensitivity as of a complex biological system, along with meteorotropic reactions of a healthy and especially sick individual, is of great medical and social importance. The climatic and geographical conditions of the individual's life environment leave its mark on the specificity of responses at fluctuations of meteorological factors.

Purpose of the research. To study meteorological factors effect on the incidence of high blood pressure in the population of Vladikavkaz from a gender perspective.

Materials and methods. We performed a retrospective analysis of the number of emergency calls (ECS[1]) of patients due to deteriorating the state of health on the background of high blood pressure. We used ambulance archive records in Vladikavkaz for the first half of 2012.

The meteoparameters data (of the average daily air temperature (0^0C), atmospheric pressure (hPa), relative humidity (%), wind speed (m/s), clouds (amount)) were obtained from the weather station site http://www.rp5.ru g, as of Vladikavkaz weather station. In addition to the absolute values, we determined partial indices of weather pathogenicity, reflecting the weather dynamics of the day by changes in the air temperature (it), humidity (ih), wind speed (iv), clouds (in), as well as the day-to-day changes in these parameters. On the basis of the partial indices, we calculated the total weather pathogenicity index (WPI), which reflects the innervating effect of weather factors on human body. [2] The statistical analysis was performed using the software package Statistica 6.0. To compare the mean values in two independent groups, we used Student's t-test. Using the analysis of variance, we evaluated weather conditions effect on the frequency of ECS calls of patients due to increased blood pressure. Using the correlation analysis, we stated the ECS calls frequency value, depending on the meteorological factors. When testing statistical hypotheses, critical significance point was accepted at ≤ 0.05.

Results and discussion. During the period under study, we analyzed 6376 cases of ECS calls (1669 men and 4707 women) due to health deteriorations (headache, nausea, vomiting, dizziness, chills) associated with arterial hypertension. The monthly average number of calls during the period under study made 44.8 ± 3.31 people. It was found that women were more likely to apply for ECS, than men (32.8 ± 2.54 12.0 ± 1.89 vs. p = 0.000014). All patients were grouped according to the age into 7 groups: 20-29, 30-39, 40-49, 50-59, 60-69, 70-79 and ≥80 years old. The gender ratio (M: F) in the respective age groups varied: 2.25: 1; 0.88: 1; 0.50: 1; 0.46: 1; 0.37:1; 0.31: 1; 0.26: 1. The basic number of the ECS calls is between the ages of 70-79 years (510: males, 1624: females).

Based upon the analysis of variance, we revealed that the adverse weather conditions have an impact on ECS frequency of calls in connection with health deterioration being accompanied by an increased blood pressure (F=12,3; p=0.00001). When exposed to the "acute" weather conditions, there is a significant increase in the frequency of ECS calls; at the "innervate" weather conditions, it does not change significantly comparing to the "optimal" weather conditions.

The analysis of correlations between meteorological parameters and the ECS calls frequency showed that the strongest relation was found with the temperature factor. Pearson's correlation coefficient in a male sampling was r=-0.37 (p= 0.00006), in female sampling r = -0.42 (p=0.00000).

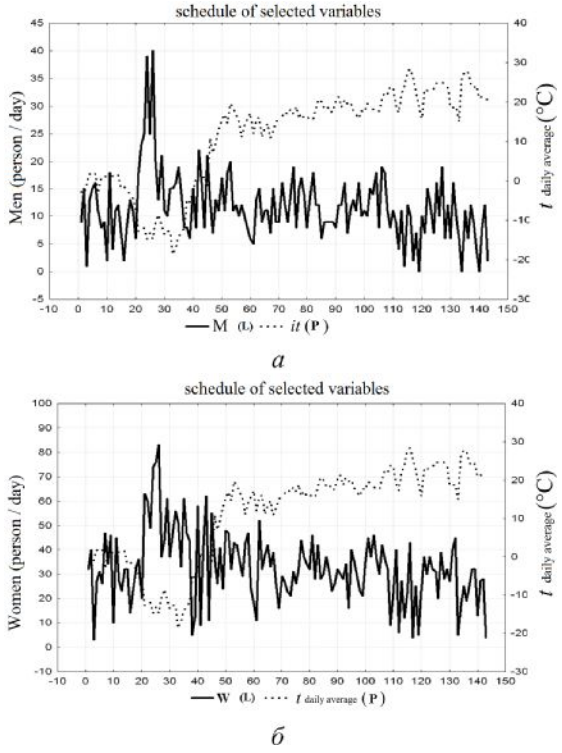

Fig. 1. Interrelation between daily average air temperature and ECS calls frequency in connection with blood pressure increase: a) in men; b) in women.

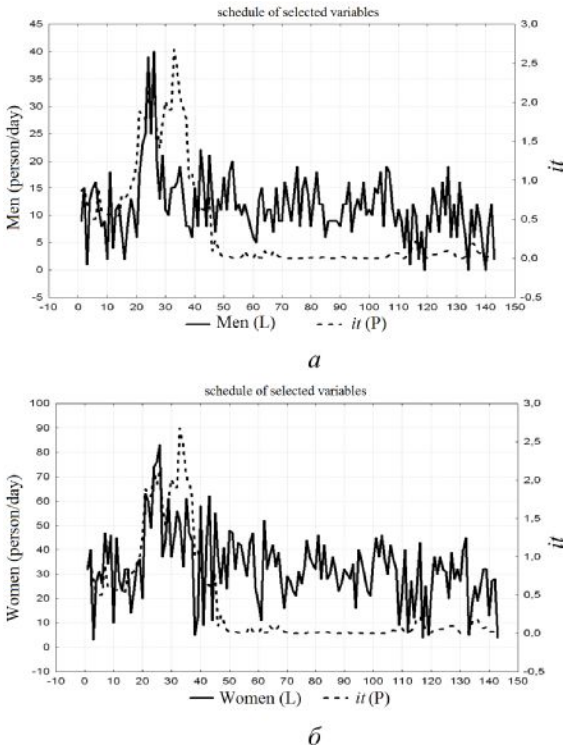

Fig. 2. Interrelation between daily average air temperature and ECS calls frequency in connection with blood pressure increase: a) in men; b) in women.

It was revealed that sharp temperature drop predispose a rise in blood pressure and patients' health deterioration, increases the number of ECS calls respectively.

The dynamics of ECS calls for men and women is slightly different. At shifting the average daily temperature to the range below -10^0C, there is a peak increase in the number of ECS calls in men observed, with a subsequent decrease to the average value (Fig. 1). Women also recorded ECS calls surge, but it remains high for a long period (17 days) (Fig. 1). The drop of air temperature under an increased atmospheric pressure generates a weather of "spastic type", precipitating the angiospastic signs of any location, accompanied by the relevant complaints and symptoms [11]. Not only the temperature factor, but the critical day-today temperature fluctuations can have negative effect on human health, especially provided the existing pathology.

We revealed positive correlation between the temperature pathogenicity index and the ECS calls frequency accompanied by an increased blood pressure, both in men (r =0.41; p=0.000002) (Fig. 2.) and women (r=0.47; p=0.000000) (Fig. 2).

In both cases, a sharp increase in the frequency of the ECS calls corresponds to the first peak of the index, followed by a decrease against the second, more evident peak. A likely explanation thereof can be the start-up of adaptation mechanisms that transfer physiological systems functions into a quasi-stable state, disturbed as a result of the adverse impact of critical fluctuations of the temperature factor.

At studying the total index of pathogenicity, including partial pathogenicity indices of various meteorological factors (it, ih, iv, in), we revealed positive correlation with the ECS calls frequency in women (r =0.24; p=0.008236). In men, no authentic connection between the exacerbations frequency and WPI identified. It can be assumed that of negative

effect on the cardiovascular system of women are not only the air temperature fluctuations, but other meteorological factors contributing to the progress of meteopathic reaction in the form of increased blood pressure.

Conclusions. The largest number of ambulance calls due to the increase in blood pressure ranges between 70 to 79 years old (gender ratio M:F - 0.31:1).

Against the "acute" weather conditions, there is an increase in the ECS calls frequency of patients due to increased blood pressure observed.

The most critical meteorological factor causing the meteorotropic reaction in the form of increased blood pressure is negative daily average air temperature (<-10^{0}C). In women, the response of the cardiovascular system to the negative effect of temperature and other meteofactors is more evident, compared to men.

Adverse weather conditions are a significant health risk factor, as they can predispose the development of cardiovascular events against the background of high blood pressure.

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HEMOBLASTOSES IN OFFSPRING OF RADIATION-HAZARDOUS INDUSTRIES WORKERS

S.F. Sosnina, N.R. Kabirova, M.E. Sokolnikov, P.V. Okatenko

Southern Urals Biophysics Institute, 19 Ozerskoe shosse, Ozersk, 454780, Russian Federation

Malignant tumors of hematopoietic and lymphoid tissues in children have polyetiologic nature, including some contribution of parents' exposure to radiation. The causal relationships between parental chronic preconceptive external gamma-irradiation and hematological malignancies in their children have been studied. Retrospective epidemiological study based on a "nested case-control approach" using matching method was carried out in the cohort of Ozyorsk pediatric population. "Case" is defined as a child under 15 years old with diagnosed hemoblastosis. The "control" group is the one without such a diagnosis. The controls were selected from the same Ozyorsk children's cohort by matching cases on sex, birth year and parents' age at children's birth. Subgroups of children who are offspring of those occupationally exposed are distinguished. Calculation odds ratio (OR) with 95 % confidence interval (CI) is performed. There were 51 children under 15 years age diagnosed with hemoblastosis in Ozyorsk within 1949–2009. The control group included 197 health children. 29.4 % (15 children) in the study group were offspring of people who had accumulated doses of preconceptive exposure, whereas in the control group the indicator is 43.1 % (85 children). The total doses of external gamma radiation on the parent's gonad varied widely (2.1–3397.3 mGy in the study group and 0.5–2899.3 mGy in the control group). The average age of leukemia contraction was 6 years without regard to sex. Acute leukemia was a major contributor to the hemoblastosis structure (66.7 % of all cases). Analysis of the data showed no statistical relationship between preconceptional prolonged external gamma-radiation exposure in parents and oncohematological pathology in their offspring. OR indicator amounted 0.55 (0.28–1.07), among boys – 0.48 (0.19–1.22), among girls – 0.64 (0.25–1.65).

Key words: *retrospective study, hematological malignancies, children, offspring of workers, preconceptive exposure, IG "Mayak", odds ratio.*

Hemoblastosis ranks first in the structure of pediatric cancer. According to the International Consortium for childhood leukemia [23], to date, there have been identified numerous potential risk factors for oncohematological diseases in children, including immunological disorders of innate and adaptive nature, polymorphism of histocompatibility system, effect of various environmental factors, including chemical mutagens and ionizing radiation.

Crump C. et al [21] colligate higher risk of acute leukemia with a high fetal growth rate. Chang J.S. and Tsai C.R. [19] consider infectious etiology (viral and bacterial infections), as a trigger factor for neoplasm. The role of prenatal and postnatal exposure to electromagnetic fields in the development of acute lymphoblastic leukemia in children is defined by Tabrici M. and Hosseini S. [22] in their work. Puumala S. et al [14] reviewing 180 articles devoted to the etiology of leukemia, emphasis on the genetic and epigenetic mechanisms of leukemia development. Analyzing molecular mechanisms of leukocytogenesis, Domninsky D.A. [3] believes that transloca-

Svetlana F. Sosnina – Candidate of Medicine, Researcher, Laboratory of Epidemiology long-term effects of radiation exposure in staff and public (e-mail: sosnina@subi.su; tel.: +7 (35130) 76627).

Nailya R. Kabirova – Researcher, Laboratory of Epidemiology long-term effects of radiation exposure in staff and public (e-mail: kabirova@subi.su; tel.: +7 (35130) 73076).

Mikhail J. Sokol'nikov – Doctor of Medicine, Head of Laboratory of Epidemiology long-term effects of radiation exposure in staff and public (e-mail: sokolnikov@subi.su; tel.: +7 (35130) 71652).

Pavel V. Okatenko – team leader of computer and software group, Laboratory of Epidemiology long-term effects of radiation exposure in staff and public (e-mail: okatenko@subi.su; tel.: +7 (35130) 76903).

tions determine hemoblastosis phenotype.

Exposure of parents to radiation before conception is considered as one of the potential risks of cancer pathology in offspring. Epidemiological studies on the effects of parental exposure were conducted among the offspring of the atomic bombing victims [20], the Chernobyl Nuclear Power Plant (CNPP) accident responders [4], the patients who underwent diagnostic and therapeutic radiation exposure [11], the descendants of professionals [7.9 12], as well as those living near the radiation-hazardous sites [16,17].

The trans-generational transmission route of cytogenetic effects, mitochondrial DNA role in cancer process, genetic and epigenetic disorders that contribute to carcinogenesis [10,13,15] are under discussion as plausible scenarios for pathogenesis of hematological malignancies in the offspring of persons exposed to pre-conceptive radiation.

Mixed results of epidemiological and molecular genetic studies do not allow for setting the causal relationship between pre-conceptive exposure of parents and hemoblastosis in their descendants. On this basis, it is important to study the carcinogenic effects of parents' exposure to radiation in offspring cohort of the workers at PE "Mayak" – the first nuclear company in Russia, which is the main employer in Ozyorsk town.

PE "Mayak", operational since 1948, includes reactor, radiochemical, plutonium processing and a number of auxiliary production units. In technology development period (1948-1958), the staff, 25% of whom were women, was under sustained exposure to external gamma- and internal alpha-irradiation with incorporated plutonium-239 in large doses.

Objective: To evaluate statistical relationship between pre-conceptive sustained external gamma radiation of the workers at PE "Mayak" and hematological malignancies in their children.

Data and methods

The study was performed based on several registers put in place and kept with epidemiological laboratory for long-term effects of radiation exposure in personnel and population of *Federal State Unitary Enterprise South-Urals Biophysics Institute*:

- Cancer-register, including data of 13,867 cancer cases among Ozyorsk population for 1948-2014.
- Pediatric register [8], which consolidates data on 90,835 people born in 1934-2009 in the town of Ozyorsk, or moved to the town at an early age and lived there for at least a year,
- Register of PE "Mayak" personnel [5], including 35,884 people employed during 1948-2014 at the enterprise operations and auxiliary plants, which served as the data source of parents' occupational route.

The study also involved info from the data file of the incident emergency workers in 1957, settlers from the East Urals Radioactive Trace, the liquidators of Chernobyl accident, info details of construction, military units, whose personnel could had been exposed to radiation before conception.

Follow-up parameters of personnel external gamma radiation exposure are provided by the radiation security service of PE "Mayak" from the Employees' Dosimetry System of Mayak-2008 [1.18]. The doses of gonad external gamma-irradiation were calculated by Monte Carlo method based on showings of personal dosimeters and spatial and energy distribution of photon radiation field at workplace. For plutonium processing personnel, we presented and studied only the doses of external gamma-irradiation.

We used statistical "nested case-control "approach. "Case" is defined as a child under 15 years old diagnosed with hemoblastosis, "control" refers to a child of the same year of birth without given diagnosis. All cases of hemoblastosis in children under the age of 15 in Ozyorsk town in the period from 1949 to 2009 were obtained from the Cancer-register (51 children: 28 boys and 23 girls). Next, using the comparable pairs, every child with hemoblastosis was given 3-4 controls from the Pediatric register matching by sex, year of birth and age of parents at child's birth (197 children with no hemolymphoblastosis diagnosed: 107 boys,

90 girls). The groups were selected among the whole children population of Ozyorsk that allowed neutralize other eventually-interfering factors, including potential technologic impact on the population due to their inhabitance in proximity to nuclear enterprises. In addition, the period under study was characterized by the same healthcare quality standard and a similar food ration for the organized groups of children.

Upon completion of these two groups formation, according to PE "Mayak" personnel register and Employees' Dosimetry System of Mayak-2008, we established the fact and the dose of parents' pre-conceptive exposure.

Each group is divided into two subgroups: children whose parents had the accumulated doses of pre-conceptive radiation, and children whose parents were not exposed to occupational radiation exposure before conception. As shown in Table 1, the proportion of irradiated parents in the control group was even higher than that of children with hematological malignancies: in the main group 29.4% (15 children) were born in families whose parents had the accumulated doses of preconceptive exposure; in the group of children without onco-hematological pathology 43.1% (85 children) were the descendants of persons occupationally exposed to radiation prior to conception.

To test the hypothesis on potential effect of parental exposure before conception to hemoblastosis development in the offspring, we calculated odds ratios with 95% confidence interval.

Table 1

Groups' dimension

Group	Number of children in a group			Irradiated parents offspring			Unexposed parents offspring		
	Total	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls
«Cases»	51	28	23	15	7	8	36	21	15
«Controls»	197	107	90	85	44	41	112	63	49

Results and discussion. According to the Cancer Register data, the first time child hemoblastosis in Ozyorsk was registered in June 1955, diagnosed with acute myeloid leukemia in the three -years old infant whose parents prior to conception were not in occupational contact with the sources of ionizing radiation. For the entire observation period (1949-2009), the boys among all children with onco-hematological pathology (51 children) became ill more often: 28 persons (54.9%). Sex ratio 1.22: 1, with predominance of boys-patients, falls into line with the published data [6.23]. The largest number of hematological malignancies was diagnosed for the periods 1961- 1970 (12 cases) and 1980-1989 (11 cases). Leukemia structure among the total chil dren population of Ozyorsk for a 60-years follow-up is presented in Figure 1.

Among the malignant neoplasms of lymphatic and hematopoietic tissues, the most common one was acute leukemia, which accounts for 66.7% (34 cases). In the structure of acute leukemia, the acute lymphoblastic leukemia dominated (58.8%), which is also a characteristic of pediatric onco-hematology [23]. The specific contribution of myeloid leukemia was 17.7% of all leukemia cases.

Leukemia ranking by sex is shown in Fig. 2. Both among boys and girls, the acute lymphoblastic leukemia ranked first, whose share made more than 39% with no significant differences by gender (39.3% boys and 39.1% girls).

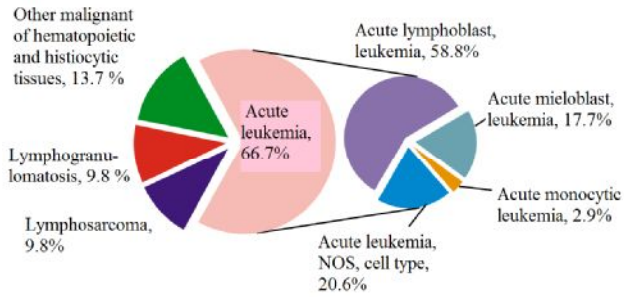

Fig.1. Leukemia structure among children population of Ozyorsk (%)

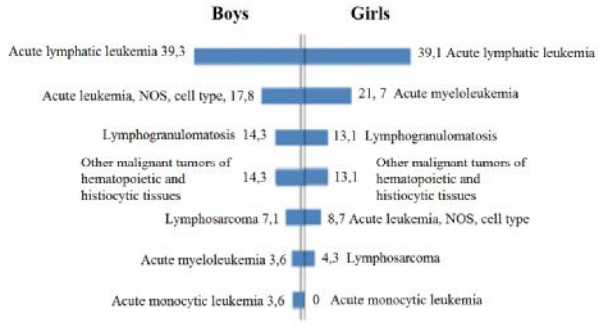

Fig.2. Leukemia ranking by sex(%)

Gender differences in the structure of children's hemolymphoblastosis were identified only for acute myeloid leukemia, ranking second in girls (21.7%), while the contribution of this pathology among boys amounted to 3.6% only. Lymphogranulomatosis occurred with equal frequency among children of both sexes: 14.3% boys and 13.1% girls. A similar percentage was noted for the subclass "Other malignant neoplasms of lymphoid and histiocytic tissues", including histiocytic lymphoma, malignant histiocytosis. Acute monocytic leukemia was the least often hematologic malignance in children. For boys, this pathology was diagnosed in 3.6% of cases, in girls - not a single case was revealed.

The mean age for hemoblastosis occurrence made 6 years old with no distinction of sex. The data on the structure of children's Leukemia as a whole and for each sex separately do not differ from the national and global statistics [6, 23].

Parents of children in both groups were exposed to a wide range of doses. Table 2 shows doses characteristics of external gamma radiation on gonad prior to conception.

Table 2

Characteristic of external gamma radiation on gonad

Doses of external gamma radiation on gonad	Irradiated parents in "cases" group		Irradiated parents in "controls" group	
	Fathers	Mothers	Fathers	Mothers
Average dose of external gamma radiation on gonads, mGy *	476.4 (21.3-3397.3)	353.9 (2.1-999.9)	441.6 (0.5-2899.3)	376.7 (2.1-1190.2)
Median dose of external gamma radiation on gonads, mGy **	149.5 (50.3-192.5)	60.0 (2.1-999.9)	167.0 (35.8-342.8)	206.9 (63.2-593.9)

*- doses range given in brackets

**- interquartile range given in brackets

Table 3

Odds ratios calculations

Group	Risk factor present			No risk factor			OR (95% CI)		
	Total	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls
Outcome present (n=51)	15	7	8	36	21	15	0.55 (0.28-1.07)	0.48 (0.19-1.22)	0.64 (0.25-1.65)
No outcome (n=197)	85	44	41	112	63	49			

The external gamma radiation accumulated doses on gonads among parents of children with hematological malignancies ranged from 2.1 to 3397.3 mGy, among the parents in the group of "controls": from 0.5 to 2899.3 mGy. Median pre-conceptive gonadal dose of external gamma radiation in the parents of children with hematological malignancies was lower than that of parents in the "controls" group. Thus, among the "cases" group mothers, the median dose was 60.0 mGy, whereas in the controls: 206.9 mGy; among the fathers of the "cases" group, the median dose reached 149.5 mGy, in the "controls" group: 167.0 mGy.

Among parents of children with hematological malignancies, the highest values of pre-conceptive doses of external gamma radiation on gonads up to 3397.3 mGy were observed among radiochemical production workers. Among parents of children without onco-hematological pathology, the highest doses (up to 2899.3 mGy) were typical for radiochemical and plutonium reprocessing staff.

The maximum values of external gamma radiation doses on gonads are registered at the beginning of the follow-up period (1949-1953), which corresponds to the highest doses of "Mayak" employees' occupational exposure in the early operational years due to shortcomings in the production process and personal protection methods.

To identify statistical relationship between the radiation risk factor effect on the workers and the outcome in the form of Leukemia in their descendants, odds ratio index was calculated. The results are shown in Table 3.

OR value in the two groups compared without distinction by gender showed no significant statistical relationship between pre-conceptive exposure of parents and hematological malignancies in their descendants: OR 0.55 (0.28-1.07). OR result in boys of 0.48 (0.19-1.22) and girls: 0.64 (0.25-1.65) also serves as a basis for the null hypothesis of no relationship between the risk factor of parent exposure prior to conception, and the outcome in offspring in the form of hemoblastosis.

According to the national and global statistics, onco-hematological pathology occurs more often in boys [8,23]. However, in our study, the risk of hematological malignancies in the offspring of the exposed parents of girls was slightly higher than that of boys. We interpret these data with caution because of the small number of cases observed (8 girls and 7 boys with hematological malignancies of irradiated parents) that requires continuous monitoring over the descendants of radiation-hazardous production workers.

Thus, our retrospective epidemiological study with a "nested case-control approach", covering the 60-year follow-up of the descendants of PE "Mayak" staff, revealed no significant causal relationship of pre-conceptive prolonged external gamma radiation of "Mayak" workers and onco-hematological pathology in their children. The link with internal exposure was out of the present study.

A number of epidemiological studies do not support association between the exposure to ionizing radiation on gonads and the development of cancer and other genetic diseases in offspring [4,12,13]. Perhaps, this is due to existence of natural repair mechanisms that weaken harmful external agents, including ionizing radiation. However, molecular genetic studies indicate high probability of undesirable mutations in the offspring of persons exposed to prolonged irradiation. Radiation-induced chromosomal instability in somatic cells is considered as oncogenic factor [2]. Polyetiology of neoplastic process and a variety of non-radiation carcinogenic factors greatly complicate choosing the determinant cause for tumor appearance.

The absence of causal relationship between parent irradiation and hemoblastosis in their offspring under the age of 15 that we've identified does not preclude their predisposition to neoplasms and probability of carcinogenic effect in the older age, as well as process onset in the form of solid cancer. In this connection, it's necessary to continue monitoring the children of workers exposed to ionizing

radiation sources to identify the long-term effects of exposure.

Conclusions:

1. Hemoblastosis structure in a cohort of children population of Ozyorsk for the period 1949-2009 is consistent with national statistics. Acute leukemia was a major contributor to the structure of malignant tumors of hematopoietic and lymphoid tissues (66.7% of all cases).

2. No effects of prolonged preconceptive external gamma-irradiation of parents gonads on the occurrence of hematological malignancies in the offspring by "nested case-control" study revealed: OR 0.55 (0.28-1.07).

3. For final conclusions on the presence of carcinogenic risk in offspring, the follow-up is to be continued, including analysis within a cohort study and the study of dose-effect relationship.

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SANITARY-EPIDEMIOLOGICAL ASSESSMENT OF QUALITY OF ATMOSPHERIC AIR IN MOSCOW

E.E. Andreeva

Administration of the Federal Service for Supervision of Consumer Rights Protection and Human Welfare in Moscow, 4/9 Grafskiy Pereulok, Moscow, 129626, Russian Federation

The results of the comparative assessment of the sanitary and epidemiological quality of the ambient air in Moscow and the Russian Federation, that demonstrate a decrease of the air pollution level in 2014 in comparison with 2012, both in Moscow and in the Russian Federation, are presented in this study. It has been noted that most of the excess of hygienic air quality standards in the areas of Russian cities are recorded on stationary observation stations situated close to the motorway, located in residential areas, and in Moscow – in the zones of industrial enterprises' impact. It has been revealed that the tendency to the reduction of the negative impact from industrial enterprises on air pollution is registered in the whole of the Russian Federation and in Moscow. It is demonstrated that the high-priority contaminating agents, the content of which for the year 2014 in the Russian Federation exceeded the hygienic daily average standards in 5 and more times, are mainly: benzo (a) pyrene, suspended substances, sulfur dioxide, benzene, formaldehyde, nitrogen dioxide, hydrogen sulfide, etc. To assess the quality of the ambient air in Moscow, the method of "inverse distance" and inter- and extrapolation of the data obtained from the observation stations on the whole territory of Moscow has been used. The study shows that the air quality of the individual administrative districts of Moscow varies considerably, and is determined by the traffic load level as well as by the volume of emissions of the industrial enterprises and the wind rose. As high-priority contaminating agents affecting the air quality, nitrogen dioxide, ammonia, benzene, suspended substances, ozone and formaldehyde are distinguished. It is noted that close to the highway near Moscow there is an excessive concentration of nitrogen dioxide, formaldehyde, phenol, and carbon monoxide, and in areas close to industrial zones – nitrogen dioxide, phenol formaldehyde and benzo (a) pyrene.

***Key words**: ambient air quality, sanitary-epidemiologic evaluation, exceeding of the hygienic standards, approximation, interpolation, extrapolation, the method of «Inverse Distance», observation stations, monitoring, high-priority contaminating agents.*

According to the World Health Organization (WHO), air pollution affects more than 80% of urban population [14]. Air pollution is a major cause of morbidity and mortality. The risk of stroke, heart diseases, lung cancer, acute and chronic respiratory diseases, including asthma, increases with air deterioration [16-20].

This problem is particularly true for Moscow, the largest city in the Russian Federation, where air quality affects health of more than 12 million people (more than 8.4% of the total population). Thus, according to the WHO experts [4], $PM_{2.5}$ particles content in the air of Moscow, with its composition of sulfates, nitrates, carbon black and other chemicals present, is about 2-2.5 times higher than the average threshold concentration (10 $\mu g/m^3$) established by the WHO. As for life expectancy of the population (according to The Economist

Elena E. Andreeva – Candidate of Medical Sciences, head, chief state sanitary doctor of the city of Moscow (e-mail: uprav@77.rospotrebnadzor.ru; tel.: +7 (495) 621-70-76).

Intelligence Unit), the city of Moscow in 2015 is only the 13th of 20 cities included in the rating of the world cities with a population of over 10 million inhabitants.

According to epidemiological and sanitary studies [1–3,8,9,11–13,15], in Moscow there are risks of assident mortality and morbidity associated with exposure to environmental factors, especially air and drinking water. The leading environment that makes risks to health is the air.

To reduce population morbidity and mortality associated with air pollution, relevant actions of both the municipal and regional, as well as federal authorities, are needed.

Requirements to the air quality and hygiene criteria for its public health safety are established by federal regulations, i.e. the laws "On the sanitary-epidemiological welfare of population" and "On air protection", as well as the sanitary rules and standards "Hygienic requirements for air quality of inhabited localities".

The target of the present study was the comparative hygienic assessment of the ambient air quality in Moscow and the Russian Federation, as well as the evaluation of the air quality in the administrative districts of Moscow.

Materials and methods. As infosources for the comparative sanitary assessment of the ambient air quality in Moscow and Russia, we used data form No: 18 "Information on the sanitary condition of the Federal Subject of Russia" approved by the Order of the Federal State Statistics Service No.673, ddt. 20.11.2014.

In order to assess air quality per administrative districts of Moscow, we used data on the content of pollutants in the ambient air for 2012-2014, obtained by "Hygiene and Epidemiology Center in Moscow" as part of the environment and health monitoring, as well as the data of the State Agency on Environment Protection "Mosekomonitoring" and "Moscow Center of hydrometeorology and monitoring of environment".

An assessment of ambient air quality in a comparative aspect with the Russian Federation and in the context of the administrative districts was carried out by the over-limits share of maximum permissible concentration (MPC) in sampling points at fixed stations, highways in the area of residential development, in the industrial enterprises affected areas (129288 samples by 25 indices).

To obtain info on the level of the mean-year concentrations, the electronic map of the city was marked with the system of calculation points as a regular grid of 3240 km^2 total area, 54×60 km size and grid points step of 200×200 m. The approximation was performed by an "inverse distance" method [10].

Upon the approximation procedure, we calculated mean indices of all the calculation points located within the borders of each administrative district.

A comparative analysis of the chemical substances concentrations (maximum of one-time and daily average) in the air of Moscow and the Russian Federation was carried out taking into account the requirements of SanPiN 2.1.6.1032-01, and *Hygienic Standards* 2.1.6.1338-03 and *Hygienic Standards* 2.1.6.2309-07.

Study results. According to the Federal Service for Surveillance over Consumer Rights Protection and Human Well-being [6], urban settlements air quality on the territory of the Russian Federation has improved. So, the share of the ambient air samples in 2014 in the cities of the Russian Federation exceeding $MPC_{o.t.}$ amounted to 1.06 ± 0.02%, which is 0.3% less than in 2012 (1.37 ± 0.02%). A similar dynamics is observed in Moscow. The proportion of air samples, incompliant with hygienic standards, decreased 2 times: from 0.43 ± 0.06% in 2012 to 0.22 ± 0.04% in 2014. It should be noted that the level of air pollution in Moscow (transient increases in concentrations) is approx. 3-5 times lower than in the RF cities on the whole.

Most often an exceedance of the air quality hygienic standards in the urban territories of the Russian Federation is being recorded at the fixed monitoring stations and close to the highways located in residential areas and in Moscow, i.e. in the affected areas of indus-

trial enterprises. However, there's a tendency of decreasing the negative effect of industrial enterprises on air pollution both in the Russian Federation on the whole, and in Moscow.

According to FSBI "Central Federal State Budget Institution" in 2014 the level of air pollution near the highways and industrial areas can be characterized as the "higher", in residential areas of the city as "low".

Priority chemicals polluting the ambient air in the Russian Federation, according to the State Report [6], include phenol, suspended particles, formaldehyde, benzo(a)pyrene, carbon monoxide. Substances that determine health situation in Moscow [5,7] are hydrogen sulfide, nitrogen dioxide, ammonia and aliphatic saturated hydrocarbons.

According to the State Report [6], in 2014 in the Russian Federation on the whole, the average daily concentrations of pollutants in the ambient air in 99.18% of samples comply with hygienic standards. Only 0.82% of samples taken in the territory of the Russian Federation in 2014 showed chemical impurities pollution in the air exceeding $MPC_{d.a.}$ (as in 2013). The exceedance of 1.1 to 2.0 $MPC_{d.a.}$ was observed in 0.71% of samples, from 2.1 to 5.0 $MPC_{d.a.}$: in 0.08% of samples, and more than 5.1 $MPC_{d.a}$:. in 0.02% of air samples.

In 2014, a 5-times or higher exceedance of the daily average hygiene standards was observed in the Russian Federation in terms of benzo(a)pyrene, suspended solids, sulfur dioxide, benzene, formaldehyde, nitrogen dioxide, hydrogen sulfide and other pollutants content in the atmosphere.

For comparative assessment of the ambient air quality in all the administrative districts of Moscow, we converted the mean-year data of the field measurements for 2012-2014 in a single array made by FSBI[1] "Moscow Central Hydrometeorological Service", branches of FSBI[1] "Moscow Center of hydrometeorology and monitoring of environment" and the State Agency on Environment Protection "Mosekomonitoring".

The ambient air quality monitoring in Moscow is done by FSBI "Moscow Central Hydrometeorological Service" at 16 fixed stations located in all districts of the city, except the Southwestern Administrative District and the Prefecture of Troitsky and Novomoskovsky Administrative Districts, branches of FSBI[1] "Moscow Center of hydrometeorology and monitoring of environment" at the route sites and departmental monitoring stations (see Figure . 1) and by the State Agency on Environment Protection "Mosekomonitoring" at 52 automatic air pollution monitoring stations (AAPMS) [5].

In 2014, the number of route sites increased to 45 (39 sites in 2012), and the departmental – reduced to 4 (5 in 2012) [5].

At FSBI1 "Moscow Center of hydrometeorology and monitoring of environment" fixed stations daily monitoring is in place, 2-4 times a day, within the timelines established by GOST 17.2.3.01-86. The fixed stations monitoring program includes 25 pollutants: suspended solids, sulfur dioxide, carbon monoxide, nitrogen oxide and nitrogen dioxide, hydrogen sulfide, phenol, hydrogen chloride, ammonia, formaldehyde, gasoline fraction hydrocarbons, benzene, xylene, toluene, acetone, benzo(a)pyrene, iron, cadmium, cobalt, manganese, copper, nickel, lead, chromium and zinc.

At the automatic air pollution monitoring stations (AAPMS) the atmospheric air is under monitoring twenty-four-seven, in real time, measuring the content of 26 substances in the ambient air which are typical for anthropogenic emissions sources in Moscow, including SPMs (PM10 and PM2.5), organic compounds, carbon dioxide and oxygen. The program also includes studies of carbon monoxide, nitrogen oxide and dioxide, the amount of hydrocarbons, ozone, sulfur dioxide, hydrogen sulfide, ammonia, formaldehyde, phenol, benzene, toluene, styrene, ethylbenzene and other substances.

The chemical substances for which the information was obtained from less than 7 monitoring stations, or all the values thereof are zero, were excluded from the analysis. To obtain comparable data on the ambient air quality in each of the administrative districts we used the method of "inverse distance".

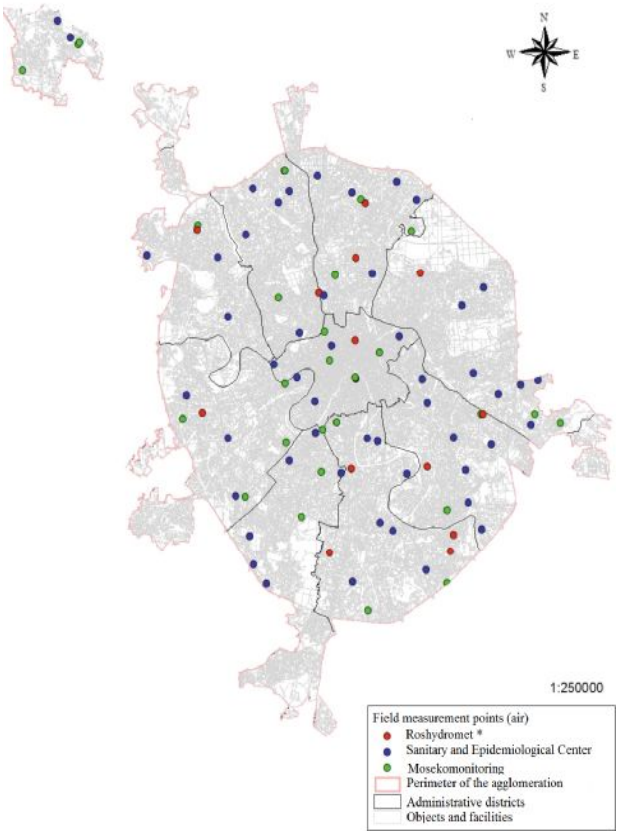


Fig. 1. Location of the monitoring stations for the ambient air quality in the city of Moscow in 2012-14
**Federal Service for Hydrometeorology and Environmental Monitoring of Russia*

The method of "inverse distance" is based on determining the "center of gravity" for a network of monitoring stations, a point whose coordinates are the arithmetic mean of the corresponding coordinates of the monitoring stations and the data interpolation within a circle of a radius 1.1R, where R is the distance between the "center of gravity" and the most remote station, in the formula (1):

$$C_{x,y} = \frac{\sum C_k / r_k}{\sum 1/r_k},$$

where C_k is the measured concentrations at the *k*-th monitoring station and at the point under consideration (regular grid point) for the respective speed scalar and wind direction; r_k is the distance from the point under consideration (x, y) to the *k*-th station.

The extrapolation outside the circle is done by the formula *(2)*:

$$C_{x,y} = \frac{\sum C_k / r_k}{\sum 1/r_k^0} + c\left(1 - 1{,}1\frac{R}{r^0}\right),$$

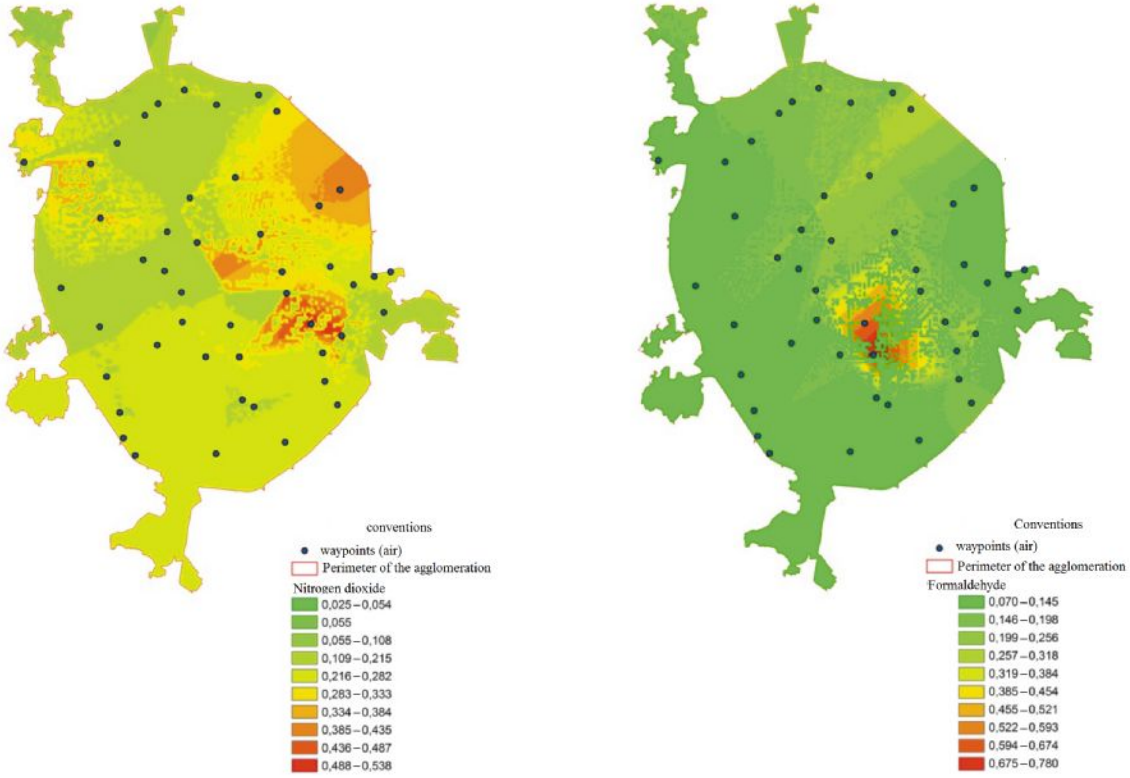
where r_k^0 is the distance from the *k*-th station to the intersection point of the circle and the straight line that connects the point under consideration with the center of gravity; r^0 is the distance from the point under consideration to the center of gravity; c is "suburban background".

The data analysis of the spatial distribution of the year-average concentrations obtained in view of data approximation procedures, allowed prioritize the administrative districts of Moscow depending on the level of pollution with certain substances, including nitrogen dioxide and formaldehyde (Fig. 2).

The mean concentrations of priority pollutants in the ambient air of Moscow administrative districts analyzed for 2012-2014 showed systematic exceedance of hygienic standards for the content of nitrogen dioxide, ammonia, benzene, suspended matters, ozone and formaldehyde.

The highest concentrations of nitrogen dioxide observed in the Northwestern, Central and Southern Administrative Districts (from 1.46 to 1.52 MPCd.a.), and the lowest – in Zelenogradsky and the Northeastern Administrative Districts (from 0.65 to 0.90 MPCd.a.). In the areas of the Eastern, Western, Northern, Southwestern and the Southern Administrative Districts there is an exceedance of the hygienic standards registered for nitrogen dioxide at the level of 1.11 to 1.34 MPCd.a.

The highest mean concentrations of ammonia are in the areas of Zelenogradsky, the Central and Northwestern Administrative Districts (from 1.2 to 1.25 MPCd.a.) lower concentrations – in the Eastern, Southwestern and the Central Administrative Districts (0.52, 0.63 and 0.71 MPCd.a., respectively).



a) nitrogen dioxide b) formaldehyde

Fig. 2. Concentrations of certain pollutants in the air, obtained by data approximation from all the monitoring stations

The mean concentrations of ammonia at about 1 MPCd.a. are registered in the air of the Northeastern, Southwestern and the Southern Administrative Districts.

The most petrol-polluted air is in the Western Administrative District (1.10 MPCd.a.), polluted with suspended solids – in Zelenogradsky Administrative District (1.07 MPCd.a.).

Ozone concentrations at the level of or exceeding the MPC for the ambient air are registered consistently in the territory of Zelenogradsky, the Northern, Northwestern, Central, Southwestern and the Southern Administrative Districts (from 1.00 to 1.36 MPCd.a.).

The most of formaldehyde is in the ambient air of the Eastern, Northeastern, Central and Southeastern Administrative Districts (from 1.03 to 1.34 MPCd.a.). In other administrative districts of Moscow the mean concentrations of formaldehyde for 2012-14 were observed at the level of 0.61 - 0.84 MPCd.a..

Conclusions. Thus, the study showed that:

1. Subject to hygienic criteria, the quality of the ambient air in Moscow is improving. The share of ambient air samples incompliant with hygienic standards, decreased 2 times (from 0.43 ± 0.06% in 2012 to 0.22 ± 0.04% in 2014).

2. The air quality of the administrative districts in Moscow greatly varies and is dependent upon the traffic, the volume of emissions from industrial enterprises and the wind pattern.

3. The priority pollutants affecting the air quality are nitrogen dioxide, ammonia, benzene, particulate matters, ozone and formaldehyde.

4. Near the highways there are observed the excess concentrations of nitrogen dioxide, formaldehyde, phenol and carbon monoxide.

5. In the proximity to industrial zones: nitrogen dioxide, formaldehyde, phenol, and benzo(a)pyrene.

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INVESTIGATIONS OF FINE PARTICLES CONCENTRATIONS IN THE ATMOSPHERIC AIR NEAR HIGHWAYS

T.S. Ulanova[1,2], M.V. Antipieva[1,3], M.V. Volkova[1,2], M.I. Gileva[1]

[1]Federal Scientific Center for Medical and Preventive Health Risk Management Technologies,
82 Monastyrskaya Str., Perm, 614045, Russian Federation
[2]Perm National Research Polytechnic University, 29 Komsomolskiy Ave., Perm, 614990, Russian Federation
[3]Perm State Agricultural Academy named after D.N. Pryanishnikova, 23 Petropavlovskaya Str.,
Perm, 614045, Russian Federation

This paper presents the results of the experimental determination of particulate matter $PM_{2,5}$, PM_{10} mass concentration and total suspended particles up to 15 microns (TSP), which are the priority components of air pollutants near the highways. The measurements were made during the year 2016 using a laser analyzer of aerosol DustTrak 8533. The study shows the dependence of the particulate matter concentration from the time of day and the traffic congestion. The sampling (N = 67) was performed due to brief program on the basis of the route monitoring station, which is located on the road junction with heavy traffic – up to1,200 vehicles per hour on the test sites. The single concentrations of the suspended substances reached the levels of the Maximum permissible concentration (MPC) of 1.5. During the study period, the exceeding of the established average daily MPC for fine particles $PM_{2.5}$ and PM_{10} fractions near the highways have not been identified.

The significant linear relationship between the number of diesel vehicles on stops and the concentrations of particulate matter $PM_{2.5}$, PM_{10}, TSP (correlation coefficient from 0.62 to 0.65; Fisher's criterion of 14.2 to 38.0; $p < 0.05$) has been established and parameterized, what allows to predict the level of air pollution by diesel vehicles when braking and accelerating.

It is recommended to fulfill continuous monitoring of the average daily and single MPC of the fine suspended particles near the roads with traffic load of 769 – 1270 or more the diesel vehicles per every 20 minutes. The obtained data may be used in evaluation of the risk to public health induced by the transport emissions as well as in the estimation of the fine particles $PM_{2.5}$, PM_{10} concentrations on the sites close to the highways of the large industrial center.

Key words: *fine particles, $PM_{2,5}$, PM_{10}, transport emissions, atmospheric air, laser nephelometry, correlation coefficient, Fisher's criterion.*

Concentrations follow-up control and decrease in air pollution with fine suspended particles PM2.5 and PM10 in large industrial cities is an urgent task of social-hygienic monitoring and human health risk management.

PM2.5 are suspended particles (solids) contained in the air, of aerodynamic diameter less than 2.5 microns, PM10 – of less than 10 microns in diameter. The fine particles pose threat to human health as they penetrate into lungs, causing a number of diseases or aggravating the existing ones [3.23]. According to scientific literature, the concentration of

Tatyana S. Ulanova – PhD, DSc, Head of Department of Analytical Chemistry Analysis, Professor of the Department of Environmental Protection (e-mail: ulanova@fcrisk.ru; tel.: +7 (342) 233-10-37).

Marina V. Antipieva – PhD, Senior Researcher, Laboratory of methods of analysis of nanomaterials and fine particles, an assistant professor of botany, genetics, plant physiology and biotechnology (e-mail: girmar@mail.ru; tel.: +7 (342) 233-10-37).

Marina V. Volkova – Chemist of the laboratory for analysis methods of nanomaterials and fine particles, Master of the Department of Environmental Protection (e-mail: volkova@fcrisk.ru; tel.: +7 (342) 233-10-37).

Marina I. Gileva – Research Engineer of the laboratory for analysis methods of nanomaterials and fine particles (e-mail: gileva@fcrisk.ru; tel.: +7 (342) 233-10-37).

PM2,5 fraction fine particles affects people mortality and cardiovascular disease occurrence [25].

Standards of fine particles content in the air are set in the official documents of the World Health Organization (WHO) and the European Union [12,24,26]. In the Russian Federation, the content of PM2,5 and PM10 fractions fine particles is subject to standardization since 2010. The daily-average maximum permissible concentration (MPC) is 0.035 mg/m3 (PM2,5) and 0.06 mg/m3 (PM10); single maximum 0.16 mg/m3 and 0.3 mg/m3; mean year: 0.025 mg/m3 and 0.04 mg/m3, respectively [7]. Follow-up control over the environment pollution with suspended particles is of high demand, however, until 2016, determining fine dust concentrations was of scientific research nature only [4-6,8, 13,14,18,22], except for the automated monitoring arranged in Moscow, St. Petersburg, Sochi, Kazan [16, 17].

With Ruling document 52.04.830-2015 "Mass concentration of PM10 and PM2.5 suspended particles in the ambient air" and RD1 52.04.840-2015 "Application of the air quality monitoring data obtained using continuous measurement methods" in force since March 2016, the reference gravimetric measurement procedure relating to mass concentration of suspended particles of less than 10 microns and less than 2.5 microns is set, which allows also to determine the correction factor for automatic analyzer.

The peculiarity of the Russian standardization system is a 20-minute data smoothing, including those obtained by means of continuous measurements methods [20]. Direct measurements methods with gas analyzers and dust meters allow for the data-fund on urban air pollution in place. [20]

Under conditions of a large industrial center, fine particles mainly come from anthropogenic sources: vehicle emissions and industry [1]. For example, in Beijing, according to estimates of Beijing Environment protection and monitoring center, PM2.5 particles are generated mainly of coal combustion and exhaust emissions [2].

A large number of fine particles appear in the process of fuel combustion and vehicle diesel-engines operation [9]. Apart from direct emission from engines, fine particles are formed as a result of roadways and tires wear. Soot fine particles, due to their small size, causing a slow natural excretion from the atmosphere, and sorption properties, can increase toxicity by absorption of harmful substances from emissions, being transported to thousands of kilometers, posing threat to human health and environment [9]. The proportion of vehicle emissions in the large cities' air pollution can reach up to 60 - 90% [10]. Vehicle emissions contain dozens of different toxic substances, among which fine particles PM2.5, PM10 are a priority, along with benzo(a)pyrene and carbon black [1.14, 15.18].

The present study was aimed at investigating the content of fine particles PM2.5, PM10 in the atmospheric air at close range of auto-roads.

Materials and methods. To determine fine particles content in the air, we used dust analyzer DustTrak, model 8533, with particles size range detected of 0.1 - 15 microns. Measuring aerosol particles mass concentration ranged within 0.01 - 150 mg/m3. [21]. Instrumental studies of fine particles and TSP content in the ambient air took place during warm season (spring - summer) in 2016. Measurements were held by the reduced monitoring program in accordance with GOST 17.2.3.01-86 on route station site, located in the areas adjacent to asphalt highways of heavy traffic: 1,200 vehicles per hour on the test areas [11]. Measurement duration and averaging period in determining single concentrations were 20 minutes, unit values were recorded per second. The device was placed at a height of 1.5 m. Measurements went along with air temperature and wind speed follow-up.

Measuring air pollution level caused by vehicle emissions [19] was carried out at different weather conditions and traffic rates. According to regulations [19], the monitoring points were selected in heavy traffic localities in the areas of frequent application of brakes,

i.e. at highways crossroads and stopping points. The passing vehicles were counted per aerosol concentrations measurements period (20 min). Vehicles were divided into two categories: petrol: cars, motorcycles; diesel: buses and cargo-trucks. In addition, they assessed air pollution with fine particles PM2.5 and PM10 at stops, where people spend a relatively short time, but supposed to be receiving a relatively high dose of fine particles.

The obtained data were compared with the maximum values of single MPC of suspended particles PM2.5 and PM10 in the populated areas atmosphere [7] (Tables 1, 2). Statistical data processing included calculation and estimation of Fisher's criterion, correlation coefficient, taking into account the significance level of <0.05.

Results and discussion. Measuring the level of pollution in the ambient air at stopping points showed that under continuous every-second measurements, including measurements during buses' deceleration, stopping and acceleration, the single concentrations of suspended particles are increasing up to 1.5 MPCSM. However, by smoothing data obtained for 20-minute interval, no MPCSM exceedence was found (Table 1, Figure 1, 2).

Linear relationship equation $y=0.0002x+0.0062$ is characterized by a correlation coefficient of 0.6452; Fisher's criterion was 38.2, $p < 0.05$, that confirms the hypothesis on a heavy contribution of diesel vehicles emissions into air pollution with fine particles.

In the process of experimental studies for the stopping point №2, far from traffic lights, in a circular movement, we obtained the dependences of suspended particles PM2.5 and PM10 mass concentrations (y), as well as of TSP, on the number of diesel engine vehicles (x) (Fig. 2).

Table 1

Measurements data of PM2.5 and PM10 fine particles single maximum concentrations, as well as total dust of up to 15 microns (TSP) at stops

Point of Measurement	Traffic load, vehicles units/20 min.		$PM_{2,5}$, ±Δ, mg/m^3 Single Max Concentration	PM_{10}, ±Δ, mg/m^3 Single Max Concentration	TSP, ±Δ, mg/m^3 Single Max Concentration
	Diesel engine	Petrol engine	MPC single max value, mg/m^3		
			0,160	0,300	–
Bus stop № 1, *n* = 4	95	836	0,025 ± 0,005	0,063 ± 0,013	0,111 ± 0,022
Bus stop № 2, *n* = 11	195	822	0,055 ± 0,011	0,073 ± 0,015	0,091 ± 0,018
Bus stop № 3, *n* = 2	80	520	0,014 ± 0,003	0,041 ± 0,008	0,079 ± 0,016
Bus stop № 4, *n* = 2	160	1400	0,027 ± 0,005	0,038 ± 0,008	0,039 ± 0,008
Bus stop № 5, *n* = 2	120	720	0,014 ± 0,003	0,030 ± 0,006	0,047 ± 0,009
Bus stop № 6, *n* = 2	40	480	0,016 ± 0,003	0,053 ± 0,011	0,095 ± 0,019

Table 2

Measurements data of $PM_{2.5}$ and PM_{10} fine particles single maximum concentrations, as well as total dust of up to 15 microns (TSP) at stops

Point of Measurement	Traffic load, vehicles units /20 min.		Single Max Concentration, $PM_{2,5}$, ±Δ, mg/m^3	Single Max Concentration, PM_{10}, ±Δ, mg/m^3	Single Max Concentration, TSP, ±Δ, mg/m^3
	Diesel engine	Petrol engine	MPC single max value, mg/m^3		
			0,160	0,300	–
Crossroad № 1, *n* = 30	120	1039	0,050 ± 0,010	0,063 ± 0,013	0,080 ± 0,016
Crossroad № 2, *n* = 4	450	3185	0,031 ± 0,006	0,040 ± 0,008	0,051 ± 0,010
Crossroad № 3, *n* = 4	277	1250	0,024 ± 0,005	0,028 ± 0,006	0,040 ± 0,008
Crossroad № 4, *n* = 2	160	1000	0,051 ± 0,010	0,093 ± 0,019	0,100 ± 0,020
Crossroad № 5, *n* = 2	100	1080	0,011 ± 0,002	0,020 ± 0,004	0,034 ± 0,007

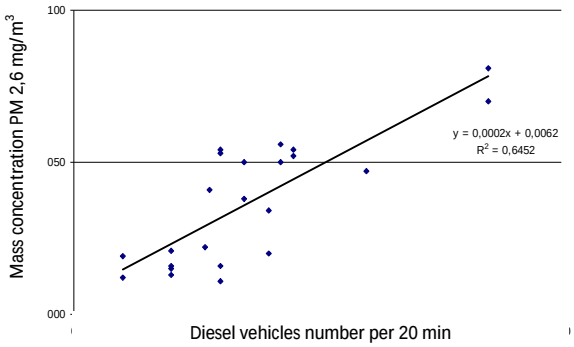

Fig.1. Dependence of single maximum concentration of PM2.5 particles at stopping points on the number of diesel engines vehicles driven along the asphalt road. N = 23, F = 38.2, p <0.05

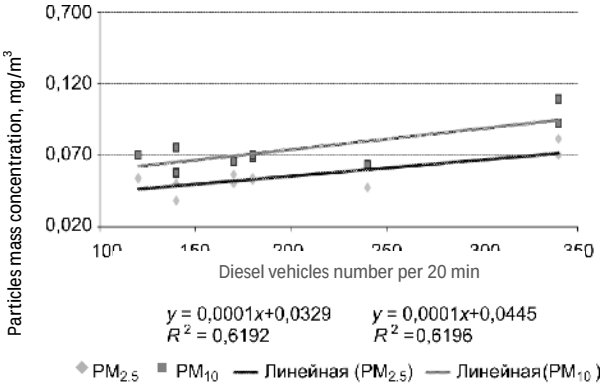

Fig.2. Dependence of single maximum concentration of $PM_{2.5}$ and PM_{10} particles at stopping point № 2 on the number of diesel engines vehicles driven along the asphalt road. N=11, F=14.6, p <0.05

Reliability of approximation and adequacy of linear dependence is confirmed with the calculated values of the correlation coefficient and Fisher's criterion: for PM2.5 y=0.0001x+0.0329 (R2=0.6192, F=14.6, p<0.05), for PM10 y=0.0001x+0.0445 (R2=0.6196, F=14.7, p<0.05), y=0.0002x+0.051, for TSP (R2=0.6203, F=14.7, p<0.05). In this case, increasing the concentration of particles in the atmosphere is linearly related to increasing the proportion of particles in the exhaust gases in conditions of braking and acceleration, and the background level of fine particles concentrations, is likely formed by exhaust gases of vehicles driven at a constant speed, and secondary dust collection from the surface. As for the other stopping points, they were near to traffic lights, so, there were braking factors, vehicles stopping and acceleration, and emissions at idling in the morning and evening traffic jams lined up herewith (Figure 3).

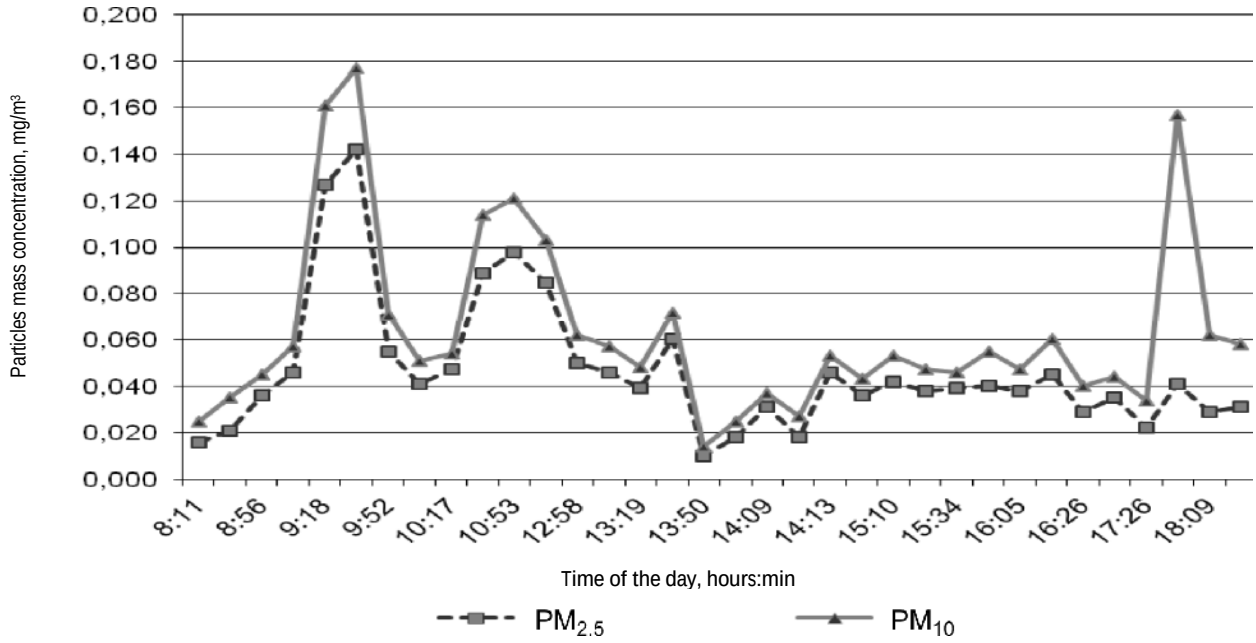

Fig. 3. Dependence of single maximum concentration of $PM_{2.5}$ and PM_{10} particles on time of the day

As per equations obtained, predicting the situation, we can assume that achieving and further exceedence of MACs.max (PM2.5) may occur at a highway stop-point loaded with diesel vehicles, the number of which within 20 minutes must exceed 770 units near the traffic lights or 1271 units far from the traffic lights. In this regard, suspended fine particles single maximum concentrations are rational to be monitored continuously near the roads with traffic close to the reported one.

The measurements results for single maximum concentrations at highways crossroads are given in Table. 2. The measured values of PM2.5 and PM10 fine particles concentrations did not exceed MACs.max. In addition, when determining single maximum concentration of fine particles at crossroads, there was no reliable dependence on the number of vehicles fixed.

Conclusions. When studying fine particles on Perm highways with the traffic intensity of up to 2.5 thousand cars per hour, suspended particles mass concentrations averaged over a 20-minute period at stops and crossroads did not exceed the established hygienic standards.

Linear dependencies between the number of diesel vehicles at stops and PM2.5, PM10, TSP suspended particles concentrations have been established and parameterized, which allows predicting the level of atmospheric pollution by diesel vehicles during their braking and acceleration.

It is recommended to continuously monitor daily average suspended fine particles concentrations near big highways, as well as single maximum concentrations of suspended fine particles near roads with diesel vehicles traffic of 769 – 1270 units or more per 20 minutes.

The studies done can be used for calculation of risks for population health due to vehicles emissions and objective assessment of PM2.5 and PM10 fine particles content near the highways of a large industrial center.

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RISK FACTORS AND PREDICTION OF PHYSICAL PROBLEMS IN CHILDREN INDUCED BY NERVOUS SYSTEM DISEASES

E.A. Vorobieva, O.M. Filkina, N.V. Dolotova

Ivanovo Research Institute of Maternity and Childhood named after V.N. Gorodkova, 109 Shuvandina Str., Ivanovo, 153045, Russian Federation

It was shown that in the conditions of intensive development of resuscitation techniques, newborn care and infant mortality reduction, including born with extremely low birth weight, one of the consequences of the process is the growing number of children with disabilities. In Russia, the disability of children under 4 years due to diseases of the nervous system consistently takes second place as on prevalence, as on the share in the structure of disability in this age. The purpose of the study was to identify risk factors and the development of prognostic tables for the most common early childhood disorders of physical health of children with disabilities due to diseases of the nervous system. A clinical examination of 178 children with disabilities due to diseases of the nervous system (with spastic forms of cerebral palsy) at the age of 1–3 years was carried out. To identify the risk factors and to draft the expectancy table, the method of sequential mathematical analysis of Wald has been used. It is shown that the priority kinds of physical health disorders of studied children with disabilities are frequent acute respiratory infections, deficient anemia, malnutrition, atopic dermatitis. It was found that during the formation of the frequent incidence of disabled children with acute respiratory diseases and atopic dermatitis neonatal and post-neonatal factors in the formation of deficiency anemia and malnutrition – antenatal and neonatal risk factors are of the greatest importance. Tables of health disorders suitable for practical use of these predictions were designed. Pediatricians recommended to include children with poor prognosis in the risk group for the formation of these health problems and prescribe preventive measures that reduce the likelihood of risk realization.

***Key words**: risk factors, prognosis of health problems, children with disabilities, cerebral palsy.*

Despite recent efforts on improving maternity and child welfare services, up to 40% children are born ill or become ill in the neonatal period [3]. Owing to an intensive development of resuscitation technologies and newborn care, infant mortality, including of extremely low-birth-weight newborns, decreased more than twice in the recent years [1, 3, 20]. Among other reasons, this led to an increase in the number of handicapped children aged up to 4 years old [14, 19, 24]. Infant disability is one of the indices that characterize children's state of health and the efficiency of public organizations that provide medical care to children [9, 11, 13]. Disability due to neuropathy consistently ranks second as in the prevalence, as well as in the share of disability state in children under the age of 4 years old [10, 13]. In occurrence thereof, perinatal factors, abnormal pregnancy and mogitocia are of critical importance [9, 17]. Infantile cerebral palsy (ICP) refers to the most severe consequences of the neural axis perinatal affections (NA PAs) and remains one of the main causes of infant disability [7, 16].

It is known that physical health of children with disabilities due to neuropathy suffers as well, which, in turn, has a significant impact on the rehabilitation potential and efficiency of complex rehabilitation [15]. Pediatric compo-

Elena A. Vorobieva – Doctor of Medical Sciences; a Leading Researcher at the Department of Child Health (e-mail: ivniideti@mail.ru; tel.: +7 (493) 233-70-55).

Olga M. Filkina – Doctor of Medical Sciences, Professor, Honored Doctor of the Russian Federation; Head of the Department of Child Health (e-mail: omfilkina@mail.ru; tel.: +7 (493) 233-70-55).

Natalia V. Dolotova – Candidate of Medical Sciences; Senior Researcher of the Department of Child Health (e-mail: ivniideti@mail.ru; tel.: +7 (493) 233-70-55).

nent therefore is an important part of the complex rehabilitation. Pediatrician involvement in rehabilitation of children with disabilities due to neuropathy is the prediction and prevention of somatic pathology. Prediction is important in the formation of children's health, since it identifies not only the risk, but also positive factors determining the application points in preventive activities to create a "preponderance" of safety factors [4]. Based thereon, both an impact of individual factors, as well as all factors in combination should be analyzed [4, 18, 21]. Prediction of the most frequent health deteriorations allows timely, targeted and differentiated preventive measures that are most effective provided their early prescription to the children at risk [2, 22, 23].

The purpose of the study was to identify risk factors and to develop prognostication for the most common early childhood physical health problems (frequent acute respiratory diseases, deficiency anemia, malnutrition, atopic dermatitis) in children with disabilities due to neuropathy.

Materials and Methods. We performed clinical examination of 178 children with disabilities due to neuropathy (infantile cerebral palsy in spastic forms), aged 1-3 years old, among them of 86 girls (48.3%) and 92 boys (51.7%), p> 0. 05. The children examination included clinical examination, evaluation of the physical growth and development, resistance, blood and urine clinical analysis. Data of the bio-anamnesis and social history were collected by data copying from the infant's records (Form No. 112-1/u), questionnaire surveys and by interviewing parents. In identifying risk factors for the most common health problems and drawing up the prognostic tables, we used sequential mathematical analysis method by Wald [5, 6]. After proving the significance of differences in the occurrence of the factor under study in the groups of children with and without disabilities ($p < 0.05$), we calculated the prognostic coefficients (PC) per each factor grade. The prognostic coefficient was calculated by the formula PC = 10 lg (P1/P2) in the presence of the factor, PC = 10 lg (1-P1/P2-1) in the absence of the factor, where P1 and P2 are the factor's occurrence in the reference groups compared. The positive sign of the value obtained testified to poor prognosis. Wald method of mathematical analysis is widely used in medicine, in particular, for prediction of diminished hearing [12], physical growth and development abnormalities, neurodevelopmental delays, frequent acute respiratory infections, formation of cerebral palsy in children with very low and extremely low birth weight [22], for prediction of disease progression in patients with chronic hepatitis C [8], etc., that makes this method topical, informative and authentic.

Results and Discussion. At clinical examination of the disabled children with cerebral palsy in spastic forms, it's found that one third of children (34.2%) are considered frequently ill, in 34.2% malnutrition is detected, in 32.6%: deficient anemia, in 18%: atopic dermatitis. In the analysis of the social history and biological anamnesis, we identified the prognostic-significant risk factors for the formation of the most common early childhood health disorders.

The most prognostic-significant for the frequent incidence of *Acute Respiratory Disease* formation in these children at early age are the following factors: premature birth of less than 30 weeks gestational age, birth weight less than 1500 grams, IVH of 1-2 degree, according to neurosonography in the neonatal period, severe neural axis perinatal affections (NA PAs), artificial respiration (AR) for more than three days, conjugation jaundice, pneumonia in the neonatal period, open fetal communication (patent foramen ovale), anemia in prematurity, adenoid hypertrophy, acute conjunctivitis history, hypertrophy of the tonsils, atopic dermatitis history, deficit of body weight, a child's ability to walk.

For deficiency anemia formation, factors of prognostic significance are: mother's age over 30 years at the time of birth, birth of the third pregnancy and more, threatened miscarriage in the first trimester, *Chronic Fetoplacental Insufficiency* during the given pregnancy, intrauterine growth restriction syndrome (IGR), 1st minute Apgar score: 6 points or less, severe NA PAs, pneumonia in the neonatal period, prematurity anemia, acute pyelone-

phritis history, intestinal dysbiosis history, spastic tetraparesis in child.

Such factors as mother's anemia during pregnancy, intrauterine growth restriction syndrome, premature birth of less than 30 weeks gestational age, birth weight less than 1500 grams, acute hypoxia and asphyxia at birth, Apgar score at the 1st minute: 0-1, 2-3rd grade IVH, according to neurosonography, 3rd-degree cerebral ischemia in the neonatal period, severe NA PAs, artificial ventilation for more than 3 days, conjugation jaundice in the newborn period, prematurity anemia, acute respiratory infections in the first year of life 4 times and more, late biekost introduction, spastic tetraparesis in child are prognostic-unfavorable for the formation of malnutrition.

For the formation of atopic dermatitis in early childhood, the following socio-biological factors are of prognostic significance: mother's age over 30 years at the time of birth, threatened miscarriage in the first trimester, acute respiratory infections in mother during pregnancy, allergic diseases in mother, chronic diseases of upper respiratory tract in mother, infectious inflammatory diseases in the neonatal period, gastrointestinal pathology in the neonatal period, obstructive bronchitis history, intestinal dysbiosis history, chronic constipation history, frequent acute respiratory infections in the first year of life, chronic diseases of upper respiratory tract of the child, food allergy history, living in a city, late biekost introduction, child's ability to walk. Therefore, when predicting frequent acute respiratory infections and atopic dermatitis in children with disabilities due to neuropathy, the largest share belongs to the neonatal and post-neonatal factors, in predicting the deficiency anemia and malnutrition – to the antenatal and neonatal risk factors.

At diagnosing and disability assessment in handicapped children due to neuropathy, at a time of preventive medical examination, pediatrician identifies social and biological risk factors of frequent acute respiratory infections, deficiency anemia, malnutrition, atopic dermatitis at the early age by interviewing parents and copying data from a child's development history.

According to the proposed prognostic table (Table), the PC values of the risk factors for each health problem revealed in a child are summed up.

Table

Prognostic table of early age frequent respiratory diseases, deficiency anemia, malnutrition, atopic dermatitis in children with disabilities as a result of neuropathy

Risk Factors	value	Prognostic Coefficients of			
		frequent ARDs	deficiency anemia	malnutrition	atopic dermatitis
Mother's age over 30 years at the time of birth	Yes		+0.90		+1.38
	No		-0.90		-1.30
Birth of the third pregnancy and more	Yes		+3.17		
	No		-1,03		
Threatened miscarriage in the first trimester	Yes		+5.3		2.43
	No		-0.98		-0.77
ARD history in the given pregnancy	Yes				+2.84
	No				-1.23
Anemia in mother during pregnancy	Yes			+3.53	
	No			-0.9	
Allergic diseases in mother	Yes				+2.45

	No				-1.12
Chronic diseases of upper respiratory tract in mother	Yes				+4.74
	No				-0.39
CFPI[1] during the given pregnancy	Yes		+2.76		
	No		-1.16		
IGR, hypotrophic by type	Yes		+5.03	+7.55	
	No		-0.73	-0.28	
Premature birth of less than 30 weeks gestational age	Yes	+3.02		+7.55	
	No	-2.15		-0.28	
Birth weight less than 1500 grams	Yes	+2.93		+10.56	
	No	-1.8		-0.64	
Acute hypoxia and asphyxia at birth	Yes			+2.56	
	No			-0.57	
1st minute Apgar score: 6 points or less	Yes		+1.04		
	No		-2.27		
1st minute Apgar score: 0-1 points	Yes			+6.14	
	No			-0.39	
IVH of 1-2d grade, according to neurosonography, in neonatal period	Yes	+1.6			
	No	-0.78			
IVH of 2-3d grade, according to neurosonography, in neonatal period	Yes			+4.46	
	No			-0.46	
3rd-degree cerebral ischemia in neonatal period	Yes			+2.62	
	No			-1.1	
Severe NA PAs in neonatal period	Yes	+1.3	+1.24	+2.43	
	No	-1.76	-1.69	-3.25	
Artificial ventilation for more than 3 days in neonatal period	Yes	+1.47		+1.07	
	No	-0.96		-1.59	
Conjugation jaundice in neonatal period	Yes	+1.82		+2.36	
	No	-0.94		-1.43	
Infectious-inflammatory diseases in neonatal period	Yes				+4.0
	No				-1.19
Pneumonia in neonatal period	Yes	+1.98	+1.42		
	No	-0.75	-0.73		
Gastrointestinal tract pathology in neonatal period	Yes				+7.55
	No				-0.28
Open Fetal Communications (OFC)	Yes	+2.29			
	No	-1.3			
Anemia in prematurity	Yes	+2.12	+2.6	+1.82	
	No	-1.25	-1.61	-0.98	
Obstructive bronchitis history	Yes				+2.43
	No				-0.77
Adenoid hypertrophy	Yes	+7.75			
	No	-1.15			
Acute conjunctivitis history	Yes	+7.02			

	No	-0.66			
Hypertrophy of tonsils	Yes	+7.2			
	No	-0.64			
Atopic dermatitis history	Yes	+3.02			
	No	-1.0			
Acute pyelonephritis history	Yes		+2.6		
	No		-1.61		
Intestinal dysbiosis history	Yes		+2.54		+4.68
	No		-0.81		-0.29
Chronic constipation history	Yes		+2.6		+4.69
	No		-1.61		-0.5
ARDs in the first year of life 4 times and more	Yes			+2.06	+2.65
	No			-1.0	-1.47
Chronic diseases of upper respiratory tract of the child	Yes				+2.97
	No				-0.88
Food allergy in anamnesis	Yes				+6.5
	No				-5.22
Living in city	Yes				+1.71
	No				-6.17
Late biekost introduction	Yes			+2.62	+2.62
	No			-1.1	-1.1
Body weight deficit in a mother???? or a child	Yes	+1.68			
	No	-1.37			
Spastic tetraparesis in a child	Yes		+2.29	+2.06	
	No		-1.24	-1.0	
An ability of a child to walking	Yes	+2.8			+2.56
	No	-2.0			-2.06

The total value of summed-up PCs determines individual prognosis. The value of the predictive threshold (PT), which allows assess the measure of confidence in the formation of health problems at early age (frequent respiratory diseases, deficiency anemia, malnutrition, atopic dermatitis) was determined by Wald formula [5]. Considering the allowable error probability in prediction below 5%, we determined that PT possibility of health disorders equals to +13, and the absence thereof: -13.

If the sum of PCs is equal to or more than 13 points, it means poor prognosis, predicting the formation of early frequent ARDs (by the sum of the 2nd column PCs), deficiency anemia (by the sum of the 3rd column PCs), malnutrition (by the sum of the 4th column PCs), atopic dermatitis (by the sum of the 5th column PCs), with a 95% accuracy of prediction.

If the PCs sum is equal to or less than -13 points, it means favorable prognosis, predicting the absence of the health disorder in question.

If the PCs sum is in the range of +12 to -12 points, the prognosis is uncertain, insufficient data to make a decision on a prognosis (the group of attention).

As for children with poor prognosis, pediatrician is to include them in a group at risk on the formation of the given health problems and prescribe the preventive measures reducing probability of risk occurrence.

Conclusion. Thus, the study revealed biological and social risk factors for the most common early age somatic disorders in children with disabilities due to neuropathy: frequent acute respiratory infections, deficiency anemia, malnutrition, atopic dermatitis. In the formation of frequent ARDs and atopic dermatitis in these children, neonatal and post-neonatal factors are the most important, in the formation of deficiency anemia and malnutrition: antenatal and neonatal risk factors. We developed easy-to-use prognostic tables for the given health disorders to be applied in pediatrician practice.

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PECULIARITIES OF TERRITORIAL DISTRIBUTION AND DYNAMICS IN RATES OF POPULATION NONCOMMUNICABLE DISEASES IN THE KRASNOYARSK REGION ASSOCIATED WITH THE INFLUENCE OF ENVIRONMENTAL RISK FACTORS

D.V. Goryaev, I.V. Tikhonova

Administration of the Federal Supervision Service for Consumer's Rights Protection and Human Welfare in the Krasnoyarsk Region, 21 Karatanova Str., Krasnoyarsk, 660049, Russian Federation

The analysis of the primary morbidity dynamics in the population of the Krasnoyarsk region is performed for the period 2005–2015. The incidence forecast by classes of ICD diseases, X revision is calculated. It was found that the figures of the first time revealed incidence in the Krasnoyarsk region exceeded the average for the Russian Federation during the years 2011–2014 on neoplasms, nervous system diseases, diseases of the circulatory and the digestive systems, diseases of the musculoskeletal system and connective tissue, endocrine diseases and a number of other systems. The values of the integral health risk indicators are calculated by the methodology of State Sanitary and Epidemiological Surveillance Agency of the year 1995. For risk characteristics the following criteria are used: integral index of health less than <0.312 – minimal risk; 0.313–0.500 – moderate risk; 0.501–0.688 – increased risk of more than 0.689 – the highest risk. It was found that the increased health risk is typical of 21 municipal territories of the region, which is home to 66.1 % of the population. Among the areas with "high" public health risk in different years were Sharypovo, Birilyussy and Evenk districts. In most areas the priorities relate to a group of non-communicable diseases associated with the negative impact of various factors of habitat population (disease of the respiratory system, circulatory system, neoplasms, including malignant, etc.). According to the forecasts in 2016 we expect the decrease in the proportion of inhabitants in the region from the group with the "moderate" and "elevated" risk, and an increase in the number of people with "high" and "minimal" risk to public health. It is shown that a number of regional municipalities have a necessity in the planning and implementation of measures to improve the population health.

***Key words**: Krasnoyarsk region, primary morbidity, integrated health assessment, risk areas.*

Mineral resources extraction, processing industries, and electricity, gas and water supply develop in the Russian Federation, and production volumes in these spheres have already been growing for a long time. It all leads to greater anthropogenic load on the environment.

Environment contamination caused by various production branches, as well as occurrence of new challenges and threats, damages population health and it is an acute ecologic problem having great social and economic significance [9,11,14].

Industrial production is concentrated in big cities and most people also live there so ecologic situation in them is rather tense and it is connected both with current enterprises functioning and ecological problems inherited from past activities [16].

Unfavorable environment existing in contemporary cities and being caused by intense contaminating emissions of industrial enterprises and transport leads to growth in morbidity and

Dmitry V. Goryaev – director, chief state sanitary doctor of the Krasnoyarsk Region (e-mail: goryaev_dv@24.rospotrebnadzor.ru; tel.: +7 (391) 226-89-50).

Irina V. Tikhonova – Head of social and hygienic monitoring (e-mail: Tihonova_iv@24.rospotrebnadzor.ru;
tel.: + 7 (391) 226-89-91).

occurrence of diseases in all population groups, first of all children; morbidity in its turn results in economic losses of the state [2,4-7,10,13,15].

It becomes quite evident that population health is an integrated index of human environment quality and its influence on life activity of a human body. Thereby public health indexes become integral indexes of medical and ecological welfare and can be used as criteria for its assessment; ecological processes can therefore be considered top determinants of human welfare [1,3,12,17].

Krasnoyarsk region can be characterized as having highly developed industry and growing contamination levels caused by motor transport. Industries on this territory exert significant influence on human environment. And here we note that population health monitoring becomes really essential as it provides data for examining influence environmental factors have on population health. It helps to create priority measures aimed at eliminating adverse effects caused by these factors as well as to assess population health and to give forecasts on it. Population health is a whole set of quantitative indexes where morbidity indexes are among the most important ones. And if we take Krasnoyarsk region we can see that average morbidity indexes for many diseases categories here constantly exceed average levels in the RF and such trends are characteristic for population health in this region.

Research goal: to assess primary morbidity levels and dynamics for Krasnoyarsk region population basing on the data provided by social and hygienic monitoring

Data and methods. To analyze primary morbidity dynamics for Krasnoyarsk region population we used data taken from the state statistic observation form No. 12 "Information on number of diseases registered in patients living in the area of a medical organization service" provided by Krasnoyarsk Public Health Ministry. The data comprised children, teenagers and adult population groups; the total population number in Krasnoyarsk region amounted to 2,866,490 people (on the 1st of January, 2015) and it was taken as per each of 55 city districts and municipal districts separately over 2005-2015 as well.

We analyzed long-term (2005-2015) primary morbidity dynamics for Krasnoyarsk region population; we calculated morbidity forecast for diseases categories taken as per International Diseases Classification, Revision X, taking all the revealed trends and correlation with average long-term indexes into account [6]. We also calculated and assessed population health "risk" degree in conformity with "Integral population health assessment on territories" guidelines [5]. Integral health index, in addition to comparison between territories, has a criterion score which corresponds to different degree of population health risk in territories: minimal risk value is less than 0.312; moderate risk value amounts to 0.313-0.500; increased risk value is 0.501-0.688; and if the value is higher than 0.689 risk is high.

We assessed authentic discrepancies between compared average values depending on t-criterion value (Student's t-criterion). We used MS Excel to analyze and statistically process the information.

Results and discussion. Primary morbidity (with a diagnosis made for the first time) among Krasnoyarsk region population amounted to 785.9 cases per 1,000 people in 2015 which was authentically lower by 2% than in 2014. Respiratory organs diseases occupy the 1st place in primary morbidity structure, both in the region as a whole and as per different age groups (children, teenagers and adults) (35.2%, 59.5%, 42.8%, 18.7% correspondingly). The 2nd place belongs to injuries, intoxications and some other consequences of external causes (13.7 %, 6.4 %, 14.6 %, and 18.5 % correspondingly). The 3rd place among children and teenagers belongs to skin and subcutaneous tissue diseases (5.2 % in the region as a whole, 4.9 % and 5.6 % correspondingly); urogenital system diseases have the same place among adults (7.4 % in the region as a whole, 11.2 % correspondingly).

Table 1 contains primary morbidity indexes for Krasnoyarsk region population taken in dynamics over 2011-2015 and

compared with average country morbidity indexes.

As per data given in Table 1, primary morbidity indexes for Krasnoyarsk region population were higher than average country indexes in 2011-2014 for such diseases as neoplasms, nervous system diseases, circulatory and digestive system diseases, musculoskeletal system and connective tissue diseases, endocrine system and urogenital system diseases, eye and ear diseases, injuries, and intoxications. Morbidity for respiratory organs diseases, blood and blood-making organs diseases, skin and subcutaneous tissue diseases in Krasnoyarsk region is lower than in the Russian Federation on average. There are no authentic discrepancies in the morbidity levels for digestive organs diseases, skin and subcutaneous tissue diseases and congenital abnormalities (malformations) between Krasnoyarsk region and the Russian Federation as a whole.

Dynamics of primary morbidity indexes for Krasnoyarsk region population in 2010-2014 is characterized with an authentic trend showing both growth and reduction and it coincides with the overall trends of changes in the whole country indexes.

Table 1

Primary morbidity dynamics in Krasnoyarsk region and in the Russian Federation, number of cases per 1000 people, ‰

Disease category, territory	year					Annual average growth rate (▲), decrease rate (▼), %
	2011*	2012*	2013	2014	2015	
Registered diseases, total						
Russian Federation[1]	796.9	793.9	799.4	787.1	n/a	▲0.2
Krasnoyarsk region	832.62	829.3	808.8	805.7	785.9	▼1.4
Some infectious and parasitic diseases						
Russian Federation[1]	32.4	32.1	30.9	30.8	n/a	▼1.7
Krasnoyarsk region	30.73	36.22	34.6	34.9	30.8	▼0.3
Neoplasms						
Russian Federation[1]	32.4	32.1	30.9	30.8	n/a	▼1.7
Krasnoyarsk region	30.73	36.22	34.6	34.9	30.8	▼0.3
Blood and blood-making organs diseases and certain disorders involving immune mechanism						
Russian Federation[1]	4.7	4.7	4.7	4.7	n/a	▼0.8
Krasnoyarsk region	4.26	4.08	3.8	3.9	3.8	▼2.6
Endocrine system diseases, digestive disorders and metabolic disorders						
Russian Federation[1]	10.3	10.6	10.6	11.2	n/a	▲2.2
Krasnoyarsk region	12.23	12.18	11.1	11.7	13.4	▲1.6
Nervous system diseases						
Russian Federation[1]	16.5	16.3	16.5	16.2	n/a	▼0.2
Krasnoyarsk region	20.01	18.24	19.0	19.1	16.9	▼2.9
Eye and its accessory apparatus diseases						
Russian Federation[1]	33.3	35.2	35.0	34.7	n/a	▲1.5
Krasnoyarsk region	47.26	45.9	44.0	43.6	41.5	▼3.1
Ear and mastoid diseases						
Russian Federation[1]	27.8	28.2	28.0	27.7	n/a	▲0.5
Krasnoyarsk region	30.28	31.35	29.8	29.9	27.7	▼2.2
Circulatory system diseases						
Russian Federation[1]	28.2	26.6	29.9	28.8	n/a	▲1.3

Disease category, territory	year					Annual average growth rate (▲), decrease rate (▼), %
	2011*	2012*	2013	2014	2015	
Krasnoyarsk region	31.35	32.78	34.4	32.9	33.9	▲0.5
Respiratory organs diseases						
Russian Federation[1]	338.8	330.9	338.4	333.4	n/a	▲0.5
Krasnoyarsk region	311.29	295.89	295.3	286.1	276.5	▼2.7
Digestive organs diseases						
Russian Federation[1]	34.8	34.8	35.2	36.6	n/a	▲2.0
Krasnoyarsk region	36.6	36.6	35.3	38.7	37.1	r 0.2
Skin and subcutaneous tissue diseases						
Russian Federation[1]	48.0	48.0	47.0	46.3	n/a	▼0.7
Krasnoyarsk region	43.77	43.77	42.3	41.5	40.8	r 0.1
Musculoskeletal system and connective tissue diseases						
Russian Federation[1]	33.6	33.2	32.3	31.8	n/a	▼1.4
Krasnoyarsk region	43.68	43.68	40.3	41.7	41.1	▼1.9
Urogenital system diseases						
Russian Federation[1]	49.3	49.6	49.8	49.0	n/a	▲0.6
Krasnoyarsk region	55.8	57.33	54.4	54.6	58.5	▲0.5
Congenital abnormalities (malformations)						
Russian Federation[1]	2.1	2.1	2.1	2.1	n/a	▲▼0.0
Krasnoyarsk region	2.12	1.78	1.9	1.8	2.1	s 0.6
Injuries. intoxications and some other consequences of external causes						
Russian Federation[1]	92.80	93.8	92.6	90.2	n/a	▼0.3
Krasnoyarsk region	111.47	113.16	107.3	109.6	108.0	▼0.9

Note: * – data taken from EMISS of Federal Service of State Statistics ; r – statistically not authentic trend; [1] – annual average growth/decrease rate is calculated for the period of 2010-2014.

Thus, morbidity level for blood and blood-making organs diseases tended to decrease with average annual decrease rate equal to 5.4% in Krasnoyarsk region and 0.8% in the Russian Federation; for nervous system diseases, 2.1% and 0.2% correspondingly; for musculoskeletal system diseases, 1.9% and 1.4% correspondingly. Morbidity levels for neoplasms and circulatory system diseases tended to grow both in Krasnoyarsk region and in the Russian Federation in 2010-2014 and annual average increase rate in Krasnoyarsk region was higher than in the RF as a whole being equal to 5.8% and 2.6% in Krasnoyarsk region correspondingly and 1.7% and 1.3% in the RF correspondingly.

Overall primary morbidity continued to decrease in Krasnoyarsk region in 2015 and annual average decrease rate over 2011-2015 was equal to 1.4%. Statistically authentic decrease in primary morbidity was detected for the following diseases: blood diseases (annual average decrease rate was equal to 2.6%); nervous system diseases (annual average decrease rate was equal to 2.8%); respiratory organs diseases (annual average decrease rate was 2.7%); eye and its accessory apparatus diseases (annual average decrease rate was equal to 3.0%); musculoskeletal system diseases (annual average decrease rate was equal to 1.9%); ear diseases (annual average decrease rate was equal to 2.2%); the data are shown in Figures 1, 2, and 3. Primary morbidity for certain diseases categories tends to grow; it is true for neoplasms (annual average growth rate is equal to 4.3%); endocrine system diseases (annual average growth rate is equal to 1.5%); circulatory system diseases (annual average growth rate is equal to 0.5%); urogenital system diseases (annual average growth is equal to 0.5%); the trend is shown in Figure 4. (The y-axis description to the left: cases per 1000 people a year).

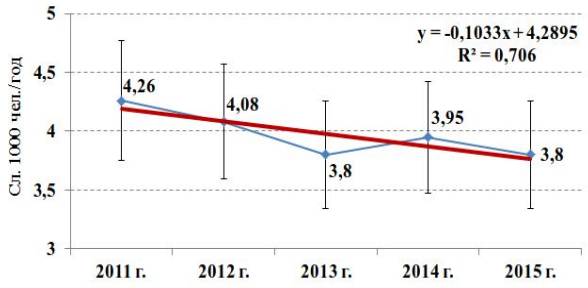

Figure 1. Decrease trend of primary morbidity for blood and blood-making organs diseases in Krasnoyarsk region, 2011-2015 ($^0/_{00}$).

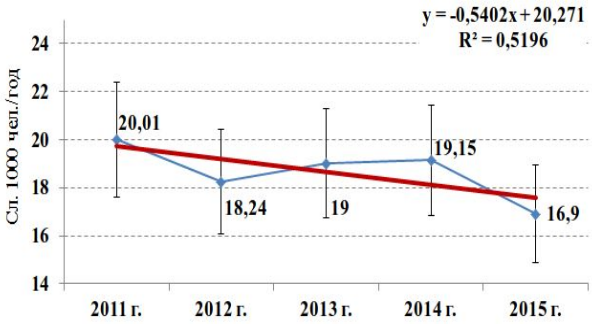

Figure 2. Decrease trend of primary morbidity for nervous system diseases in Krasnoyarsk region, 2011-2015 ($^0/_{00}$)

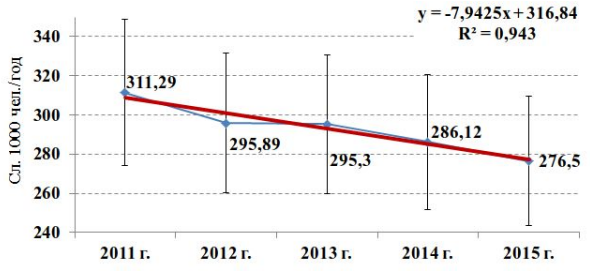

Figure 3. Decrease trend of primary morbidity for respiratory organs diseases in Krasnoyarsk region, 2011-2015 ($^0/_{00}$)

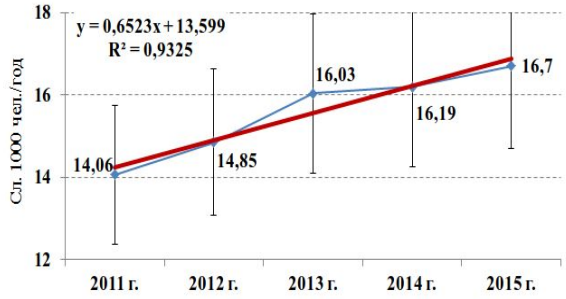

Figure 4. Increase trend of primary morbidity for neoplasms in Krasnoyarsk region, 2011-2015 ($^0/_{00}$)

Table 2

Dynamics and forecast of primary morbidity indexes for Krasnoyarsk region population (p <0.005)

Disease category	Annual average growth rate (▲), decrease rate (▼), %	Forecast, 2016.		forecast, 2017.	
		Index	Δ	Index	Δ
Total number of diseases	▲0.2	824.0	0.44	825.6	0.44
Some infectious and parasitic diseases	▼2.9	30.1	0.2	29.1	0.19
Neoplasms	▲3.98	17.3	0.15	17.8	0.15
Blood and blood-making organs diseases and some disorders involving immune mechanism	▼1.1	3.97	0.07	3.92	0.07
Endocrine system diseases, digestive disorders and metabolic disorders	▲2.3	12.9	0.13	13.2	0.13
Nervous system diseases	▲1.2	19.7	0.16	19.9	0.16
Eye and its accessory apparatus diseases	▼0.3	44.4	0.24	44.3	0.24
Ear and mastoid diseases	▲0.8	30.6	0.2	30.8	0.2
Circulatory system diseases	▲0.5	34.7	0.2	34.9	0.2
Respiratory organs diseases	▲0.8	301.3	0.53	303.6	0.53
Digestive organs diseases	▲0.3	38.5	0.22	38.6	0.22
Skin and subcutaneous system diseases	▼3.7	36.5	0.22	34.7	0.21
Musculoskeletal system and connective tissue diseases	▲0.5	43.4	0.23	43.6	0.24
Urogenital system diseases	▲1.5	59.6	0.27	60.5	0.28
Injuries, intoxications and some other external causes consequences	▼0.2	109.1	0.36	108.9	0.36

Note: Δ is confidence interval

According to forecast calculations performed on the basis of long-term observations (2005-2015) of primary morbidity in Krasnoyarsk region we can expect possible growth in morbidity indexes for all diseases categories by 2016-2017, except blood diseases, blood-making organs diseases and certain disorders involving immune mechanism, skin and subcutaneous tissue diseases, eye and its accessory apparatus diseases, infectious and parasitic diseases, injuries and intoxications (Table 2).

As we looked into territorial distribution of population morbidity indexes we detected that primary morbidity indexes for main diseases categories in some Krasnoyarsk region territories are authentically 1.5 and more times higher than in the region as a whole (Student's t criterion is > 2), and such territories can be considered "risk" ones. Risk territories where primary morbidity levels exceed average regional one include Idrinskiy district and Shushenskiy district (12 diseases categories); Norilsk, Evenkiyskiy district, Krasnoyarsk, Nazarovo (11 diseases categories); Achinsk and Dzerzhinskiy district (10 diseases categories); Minusinsk, Sharyipovo and Taseevskiy district (9 diseases categories); Divnogorsk, Lesosibirsk, Balakhtinsliy district, Bolsheuluyskiy district, Severo-Eniseyskiy district, Uzhurskiy district (8 diseases categories); Bogotolskiy district (7 diseases categories); Birilyusskiy district (6 diseases categories); Kuraginsliy district (5 diseases categories).

The accomplished analysis of population health indexes in 55 urban districts and municipal districts of Krasnoyarsk region revealed that diseases caused by various adverse environmental factors prevail in most territories. We also determined risk territories where levels of primary morbidity caused by environmental factors effects were authentically 1.5 and more times higher than average regional levels. 15 territories were included into risk category as per neoplasms; 19 territories, as per blood and blood-making organs diseases; 16 territories, as per endocrine system diseases; 13 territories, as per nervous system diseases; 25 territories, as per circulatory system diseases; 21 territories, as per respiratory organs diseases; 11 territories, as per malignant neoplasms (Table 3).

Table 3

The list of Krasnoyarsk region territories where level of primary morbidity caused by environmental factors effects was authentically higher than average regional level, 2015

Disease category	City or municipal district
Neoplasms	Achinsk, Divnogorsk, Krasnoyarsk, Minusinsk, Nazarovo, Norilsk, Sharyipovo, Bolsheuluyskiy district, Eniseyskiy district, Idrinskiy district, Kezhemskiy district, Kuraginskiy district, Nizhneingashskiy district, Severo-Eniseyskiy district, Shushenskiy district
Blood and blood-making organs diseases and certain disorders involving immune mechanism	Lesosibirsk, Minusinsk, Sharyipovo, Balakhtinskiy district, Birilyusskiy district, Bogotolskiy district, Dzerzhinskiy district, Eniseyskiy district, Ermakovskiy district, Idrinskiy district, Kazachinskiy district, Kozulskiy district, Kuraginskiy district, Novosyolovskiy district, Taseevskiy district, Turukhanskiy district, Uzhurskiy district, Shushenskiy district, Evenkiyskiy district
Endocrine system diseases, digestive disorders and metabolic disorders	Divnogorsk, Krasnoyarsk, Minusinsk, Sharyipovo, Berezovskiy district, Bogotolskiy district, Dzerzhinskiy district, Idrinskiy district, Irbeyskiy district, Karatuzskiy district, Kozulskiy district, Novosyolovskiy district, Pirovskiy district, Sayanskiy district, Shushenskiy district, Evenkiyskiy district
Nervous system diseases	Achinsk, Krasnoyarsk, Krasnoyarsk, Nazarovo, Birilyusskiy district, Dzerzhinskiy district, Idrinskiy district, Krasnoturanskiy district, Kuraginskiy district, Taseevskiy district, Uzhurskiy district, Shushenskiy district, Evenkiyskiy district
Circulatory system diseases	Krasnoyarsk, Lesosibirsk, Minusinsk, Nazarovo, Norilsk, Balakhtinskiy district, Berezovskiy district, Birilyusskiy district, Bogotolskiy district, Bolshemurtinskiy district, Bolsheuluyskiy district, Dzerzhinskiy district, Ermakovskiy district, Idrinskiy district, Karatuzskiy district, Krasnoturanskiy district, Kuraginskiy district, Manskiy district, Motyiginskiy district, Severo-Eniseyskiy district, Taseevskiy district, Turukhanskiy district, Uzhurskiy district, Shushenskiy district, Evenkiyskiy

Disease category	City or municipal district
	district
Respiratory organs diseases	Achinsk, Borodino, Divnogorsk, Kansk, Lesosibirsk, Nazarovo, Norilsk, Sharyipovo, Balakhtinskiy district, Boguchanskiy district, Partizanskiy district, Ryibinskiy district, Severo-Eniseyskiy district, Sukhobuzimskiy district, Taymyirskiy district, Dolgano-Nanatskiy district, Taseevskiy district, Turukhanskiy district, Tyukhtetskiy district, Uzhurskiy district, Shushenskiy district, Evenkiyskiy district
Malignant neoplasms	Achinsk and Achinskiy district, Borodino, Krasnoyarsk, Lesosibirsk, Minusinsk and Minusinskiy district, Sharyipovo and Sharyipovskiy district, Berezovskiy district, Ermakovskiy district, Novosyolovskiy district, Sukhobuzimskiy district, Shushenskiy district

Table 4

Population number who live in Krasnoyarsk region territories with different health risk degree in 2014-2016

Risk degree	2014		2015		2016	
	Population number	Share of total population, %	Population number	Share of total population, %	Population number	Share of total population, %
Minimal	238339	8.9	453004	16.8	490395	18.2
Moderate	638512	23.8	444119	16.5	416778	15.4
Increased	1734978	64.6	1778952	66.1	1733814	64.2
High	72790	2.7	15425	0.6	59198	2.2

The analysis shows that diseases registration frequency is the highest in such industrial cities as Achinsk, Krasnoyarsk, Lesosibirsk, Minusinsk, Nazarovo, and Norilsk, where population is influenced by apparent chemical load.

We assessed and compared degree of population health risk in urban districts and municipal districts of Krasnoyarsk region basing on the integral index calculation [16] with the use of the data collected over long-term observation period. The results show that "increased" degree of population health risk in 2015 was detected in 21 territories where 66.1% of Krasnoyarsk region population live. These territories include Achinsk, Divnogorsk, Krasnoyarsk, Norilsk, Lesosibirsk, Minusinsk, Nazarovo, Sharyipovo, Achinskiy district, Achinskiy district, Bogotolskiy district, Bolsheuluyskiy district, Dzerzhinskiy district, Idrinskiy district, Krasnoturansliy district, Minusinskiy district, Nazarovskiy district, Taseevskiy district, Uzhurskiy district, Sharyipovskiy district, Shushenskiy district. In 2015 Evenkiyskiy district was included into "high population health risk" category (in 2014 this category included Sharyipovo, Birilyusskiy district and Evenkiyskiy district). According to forecasts, in 2016 we expect to see decrease in specific weight of the region population who are included into "moderate health risk" and "increased health risk" categories and growth in population who are included into "high health risk" and " minimal health risk" categories (Table 4).

So, population health in Krasnoyarsk region expressed in terms of primary morbidity indexes is characterized with high levels of non-infectious morbidity, including one caused by environmental factors; these levels are higher than average country ones.

Population morbidity indexes for various diseases categories have been changing in both directions over the last few years in Krasnoyarsk region, growing and falling; such trends are characteristic both for the Russian Federation as a whole and Krasnoyarsk region, but decrease and increase rates for several indexes in Krasnoyarsk region are higher. As forecast calculations based on the data received from long-term observations show, by 2016-2017 we can expect to see possible growth in primary morbidity of Krasnoyarsk region population.

Territorial distribution reveals that primary morbidity levels in significant number of cities and districts in Krasnoyarsk region are statistically authentically higher than average regional levels; morbidity registration frequency is the highest in industrial cities where chemical load is apparent; such cities are Achinck, Krasnoyarsk, Lesosibirsk, Minusinsk, Nazarovo, and Norilsk, including areas adjacent to them, where 66.1% of Krasnoyarsk region population live.

Conclusion: Population health in Krasnoyarsk region is characterized with high indexes of non-infectious morbidity related to various risk factors influence. The accomplished comparative assessment of population health gives health characteristics on territorial-population level; it helps to determine problem territories where measures aimed at health improvement and morbidity prevention are to be implemented.

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ESTIMATION OF RISK TO HEALTH OF THE POPULATION OF MINING TERRITORIES OF BASHKORTOSTAN CONNECTED WITH QUALITY OF DRINKING WATER SUPPLY

R.A. Suleimanov, A.B. Bakirov, T.K. Valeev, N.R. Rakhmatullin, Z.B. Baktybaeva, R.A. Daukaev, N.N. Egorova

Ufa Research Institute of Occupational Health and Human Ecology, 94 Stepana Kuvykina Str., Ufa, 450106, Russian Federation

The ecology-hygienic problems connected with quality of drinking water supply of the settlements, located on territories with the developed mining industry are considered in this article.

Poor quality of drinking water represents risk to health of the population and, according to the WHO's data, it provides the risk of occurrence of those or other diseases on 7 %. The mining enterprises are significant sources of pollution of objects of environment, including underground water horizons as their activity is interfaced to formation of great volumes of the waste containing zinc, copper, arsenic, lead, manganese, cadmium, mercury, chrome, etc. Morbidity of the population living in regions with the developed mining industry, is raised on the number of classes of illnesses and separate nosologies (illnesses of cardiocirculatory system, urinogenital system, organs of digestion, etc.).

The purpose of this research was carrying out of an estimation of quality of sources of drinking water supply and definition of an existing risk level to health of the population of mining territories with the subsequent development of hygienic recommendations and actions on optimization of conditions of water use. Hygienic researches are lead in settlements of mining territories of Republic Bashkortostan. Thirty settlements with the population of more than 200 thousand people were included into this research. The special attention was given to non-centralized sources of water supply (chinks, wells, springs) of mining territories used by inhabitants for the domestic and drinking purposes. It is established, that the qualitative structure of drinking water of investigated territories is characterized by the raised rigidity, the high concentration of iron, nitrates, chrome, cadmium. In separate territories of investigated region the unacceptable level of total olfactory risk, connected with the high concentration of iron and the raised rigidity of drinking water was revealed. Parameters of not cancerogenic risk, define high probability of development of a pathology from cardiovascular system, system of blood. The calculated levels of cancerogenic risks are estimated as unacceptable, testifying about existence of potential health hazard of the population.

Key words: *the mining territories, not centralized water supply, quality of drinking water, hygienic researches, risk to health of the population, a level of cancerogenic and not cancerogenic danger, parameters of disease, priority polluting substances.*

Introduction. People in some world regions, including Russia, have to use water which doesn't correspond to hygienic standards. It causes substantial health risks and may

Rafail A. Suleimanov – Doctor of Medical Science, Chief of Medical Ecology Department (e-mail: rafs52@mail.ru; tel.: +7 (347) 255-46-21).

Akhat B. Bakirov – Academician of the Academy of Sciences of the Republic of Bashkortostan, Doctor of Medical Science, professor, director of the Institute (e-mail: fbun@uniimtech.ru; tel.: +7 (347) 255-19-57).

Timur K. Valeev – PhD in Biological Science, Senior Researcher of Medical Ecology Department (e-mail: valeevtk2011@mail.ru; tel.: +7 (347) 255-46-21).

Nail R. Rakhmatullin – PhD in Biological Science, Senior Researcher of Medical Ecology Department (e-mail: rnrnii2011@mail.ru; tel.: +7 (347) 255-46-21).

Zulfiya B. Baktybaeva – PhD in Biological Science, Senior Researcher of Medical Ecology Department (e-mail: baktybaeva@mail.ru; tel.: +7 (347) 255-46-21).

Rustem A. Daukaev – PhD in Biological Science, Head of Chemical and Analytical Department (e-mail: ufa.lab@yandex.ru.; tel.: +7 (347) 255-19-12).

Natalya N. Egorova – Doctor of Medical Science, a leading researcher at the Medical Ecology Department (e-mail: profanrb@gmail.com; tel.: +7 (347) 255-46-21).

lead to certain diseases evolvement [5, 9, 15-17]. An issue of supplying qualitative drinking water to population in rural regions is particularly vital as 60% of decentralized water supply sources (wells and springs) do not conform to sanitary requirements.

Morbidity of population living in areas where mining industry is well-developed, both in Bashkortostan and Russian as a whole, exceeds average country levels for a number of diseases categories and certain nosologies. The analysis of data and parameters provided by Federal Information Fund for Social and Hygienic Monitoring showed that Republic of Bashkortostan was a risk territory as per overall morbidity level of adult population, digestive organs diseases, urogenital system diseases, and respiratory organs diseases [6]. Circulatory system diseases, urogenital system diseases, and digestive organs diseases are the most significant nosologies in the overall morbidity structure for population living in the examined areas in Bashkortostan as their levels exceed average morbidity levels detected in the republic. Overall morbidity of adult population living in south-eastern regions of Bashkortostan authentically exceeds average republic levels, both in general and in neoplasms category [2, 12].

Anthropogenic and technogenic load which occurs on urbanized and rural areas is characterized by a multi-environment influence and a great variability in levels of basic environmental factors [4]. Mining areas in south-eastern regions of Bashkortostan are influenced by a complex of hazardous technogenic and environmental factors. More than 1 billion tons of wastes have been accumulated on territories belonging to mining enterprises in Bashkortostan; such wastes include offgrade ores and barren rocks (Baimakskiy copper-sulfur works has accumulated about 500 million tons; Uchalinskiy ore mining and processing works, about 300 million tons; Buribaevskiy ore mining and processing works, about 10 million tons etc.). Wastes of such enterprises contain heavy metals, such as zinc, copper, arsenic, lead, manganese, cadmium, mercury, chromium, etc. Average annual volume of wastes generated by mining industry amounts to 44% of overall wastes volume in the whole republic [10, 13]. Such a considerable volume of wastes accumulated on limited areas causes tense ecologic situation there where mining enterprises are located as well as beyond boundaries of their location. Regular manufacturing activities performed by mining enterprises exert additional negative influence on environmental objects, including underground water horizons which serve as drinking water supply sources for population [3, 13, 14].

Besides, agricultural enterprises which are sufficiently developed in south-eastern regions of Bashkortostan also make their negative contribution into natural waters contamination. Agricultural production intensifies, large stock-rising complexes are built, soils are polluted with chemicals, and new agricultural processing enterprises are created; it all leads to natural waters contamination and to poorer ecological situation in the region in general [1].

Research goal: to assess quality of drinking water supply sources and to detect health risk level for population living in mining areas; to work out hygienic recommendations and measures aimed at water consumption optimization.

Research objects and methods. Hygienic research was performed in settlements located in mining areas of Bashkortostan, namely in Beloretskiy, Abzelilovskiy, Uchalinskiy, and Baimakskiy administrative districts. Research comprised 30 settlements with total amount of population equal to more than 200 thousand people. Samples taken from underground water sources were analyzed as per basic priority parameters characterizing water quality as per organoleptic, overall sanitary, and sanitary-toxicological hazardous properties (Test-analytical center of the Institute is accredited in the Russian Accreditation system as per its technical competence and independence; accreditation certificate No. ROSS RU. 0001.510411 is valid till July 26, 2018). When we conducted our own research we paid special attention to decentralized water supply

sources (wells and springs) which were used by people living in mining areas for their household activities. Risk analysis and calculation as per organoleptic parameters of underground waters quality was performed in full conformity with methodical guidelines [7]; carcinogenic and non-carcinogenic effects were estimated according to Guide [8]. When assessing actual contamination level for centralized water supply sources we also took data provided by laboratories of inter-district hygiene and epidemiology centers in Bashkortostan into account.

Research results and discussion. The accomplished examination of water samples taken from centralized water supply systems in main cities and district centers located on mining areas of Bashkortostan (Beloretskiy, Abzelilovskiy, Uchalinskiy, and Baimakskiy administrative districts) revealed that drinking water quality in general corresponded to hygienic requirements. Drinking water had average hardness, contained a moderate amount of iron, zinc, copper, lead, manganese, chromium, cadmium, nitrates, sulfates, etc. It was also proved by the research data taken from laboratories of Hygiene and Epidemiology Center inter-district branches.

Certain rural areas in the examined region had no centralized water supply systems at all or they had such systems only partly; people living in such areas used alternative water sources (wells and springs) for their household needs.

Examination of water taken from decentralized water supply sources revealed that drinking water quality didn't conform to hygienic requirements in certain areas. The most significant water contamination parameters were increased hardness, high content of iron, calcium, and nitrates, as well as cadmium and hexavalent chromium presence concentrations very close to maximum permissible levels (Table 1).

Table 1

Most significant parameters of underground drinking waters contamination in mining areas in Bashkortostan

Parameters	MPC	Maximum values of parameters concentrations on certain areas			
		Uchalinskiy district	Beloretskiy district	Baimakskiy district	Abzelilovsliy district
Iron, mg/l	0.30	0.35	1,80	0,56	0,30
Chromium (VI), mg/l	0.05	0.05	0,05	0,03	0,05
Cadmium, mg/l	0.001	0.001	0,001	0,0008	0,001
Calcium, mg/l	-	156.3	120,2	220,5	170,3
Hardness, ºЖ	7-10	9.5	14,0	16,3	13,5
Nitrates, mg/l	45	48	33	112	56

Table 2

Calculation results for organoleptic risk of water taken from a well located in village of Halilovo, Baimakskiy district, Bashkortostan

Analyzed parameter	Value (concentration)	Prob	Risk
Manganese	0.04	-3.321	0.0005
Copper	0.01	-8.645	2.80E-18
Iron (total)	0.56	-1.100	**0.136**
Chlorides	91.2	-3.939	4.09E-05
Overall mineralization	1261	-1.665	0.048
Overall hardness	16.3	-0.781	**0.217**
Maximum value	-	-0.781	0.217

Table 3

Non-carcinogenic risk related to water consumption in some settlements of Baimakskiy district, Bashkortostan

Organs and systems	Bogachevo	Karatamak	Tavyikaevo	Yulyik	Verkhne-Yakibaevo	Saigafar
Central nervous system	0.02	0.08	0.07	0.09	0.05	0.05
Cardiovascular system	**3.00**	**1.35**	**2.53**	**2.09**	**1.90**	**3.00**
Blood system	**3.03**	**1.35**	**2.53**	**2.09**	**1.90**	**3.00**
Immune system	0.014	0.003	0.003	0.007	0.010	0.016
Reproductive system	0.026	0.16	0.174	0.15	0.11	0.033
Gastrointestinal tract	0.43	0.04	0.037	0.028	0.018	0.042
Kidneys	0.63	0.18	0.23	0.20	0.10	0.28
Liver	0.43	0.04	0.037	0.028	0.018	0.042
Skin	0.05	0.05	0.03	0.16	0.018	0.08
Hormonal system	0.12	0.20	0.21	0.21	0.12	0.05
Biochemical parameters	0.11	0.27	0.33	0.25	0.17	0.25
Mucous tunics	0.48	0.08	0.06	0.19	0.03	0.10
Development	0.012	0.16	0.171	0.14	0.10	0.017

Content of arsenic, lead, strontium, silver, copper, zinc, aluminum, manganese, nickel and other metals in drinking waters didn't exceed sanitary-hygienic standards in any settlement. We should note that we detected general coliform and thermo-tolerant coliform bacteria in water taken from water supply sources in some settlements; such water is dangerous to drink as per epidemiologic parameters.

Analysis of actual fluoride-ions concentrations was also a significant criterion used in drinking water quality assessment. The research showed that fluoride-ions content in water taken from centralized water supply system was within 0.01-0.25 mg/l range, and within 0.01-0.12 mg/l range for decentralized water supply sources. We should note that underground waters used for centralized and decentralized water supply system on most territories of Beloretskiy, Abzelilovskiy, Uchalinskiy, and Baimakskiy administrative districts cannot be considered physiologically full-fledged as they contain less than 0.3 mg/l fluorine and are classified as water sources with low fluorine content. The detected fluorine deficiency can cause increased morbidity in teeth caries and it may contribute into certain chronic septic and rheumatoid diseases evolvement.

When assessing organoleptic risk, we determined priority parameters rated as per their influence on organoleptic water properties; these parameters included manganese, copper, overall iron, chlorides, as well as such aggregated parameters as overall mineralization and hardness. According to MG [7], overall organoleptic risk is estimated via choosing its maximum value out of all values characterizing each parameter. Acceptable risk value for reflex-olfactory hazardous effects amounts to 0.1 (or 10%).

As calculation results revealed, unacceptable level of total organoleptic risk occurred on certain territories of the examined region; this risk was related to high iron contents and increased hardness of drinking water. For example, risk parameters values for water taken from a well located in village of Halilovo amounted to 0.1365 as per iron content, and 0.217 as per

hardness, and such organoleptic risk level can be classified as unacceptable according to MG [7] (Table 2).

Similar results were obtained in other settlements, namely V.Avzyan, Utkalyovo, and Buganak villages (Beloretskiy district), "Yuzhniy" microdistrict of Uchaly city (Uchalinskiy district), Tavyikaevo and Bogachevo villages (Baimakskiy district), Novobalanovo and Baimovo villages (Abzelilovskiy district).

The obtained results of non-carcinogenic risk assessment for risks related to drinking water consumption revealed that people living in some settlements of the examined region ran the risk of pathologies evolving in cardiovascular system (hazardous indexes (HI) amounted to 1.01-5.46) related to increased nitrates content in water, and in blood system (HI amounted to 1.01-5.66) related to nitrates, manganese, iron, and lead content.

The most unfavorable situation was detected in Baimakskiy district, in Bogachevo village (HI amounted to 3.0-3.03), Karatamak village (HI amounted to 1.35), Nizhnee Idrisovo village (HI amounted to 2.22), Tavyikaevo village (HI amounted to 2.53), Yulyik village (HI amounted to 2.09), Verkhneyaikbaevo and Ishmukhametovo villages (HI amounted to 1.90), Saigafar village (HI amounted to 3.0) (Table 3).

High non-carcinogenic risk levels were also detected on other areas, namely in Yuldashevo village (HI amounted to 1.09-1.16), Saitakovo village (HI amounted to 5.46-5.66), Uchaly (HI amounted to 1.09-1.40) of Uchalinskiy district; Geologorazvedka vilalge (HI amounted to 1.21), Novobalanovo village (HI amounted to 0.93), Baimovo village (HI amounted to 1.02) of Abzelilovskiy district and in Ishlya village of Beloretskiy district (HI amounted to 1.01).

To assess carcinogenic health risk at oral introduction of substances with water we determined 4 substances with carcinogenic effects, namely cadmium, lead, hexavalent chromium, and benzpyrene. The examination revealed that total individual carcinogenic risk related to use of decentralized water supply sources by population living in the examined region exceeded 1,00E-03 on some territories; according to Guide [8], such risk level corresponds to the 4th category and is considered to be unacceptable, both for population and professional groups. Such high carcinogenic risks level was registered in certain settlements in Beloretskiy district (it was 1.14E-03 in Slantsyi village, 1.00E-03 in Azikeevo village) and Abzelilovskiy district (baimovo and Tashbulatovo villages, 1.00E-03). Carcinogenic risk on these territories was caused by chromium content (3.4E-04 – 8.4E-04) and benzpyrene content (2.9E-04 – 6.6E-04) in water.

Decentralized water supply sources on most territories of Bashkortostan south-eastern region belonged to the 3rd category of the conventional risk levels classification (more than 1.0E-04, but less than 1.0E-03) characterized as "acceptable for professional groups but unacceptable for population in general". Chromium, benzpyrene, and lead were the main components causing increased carcinogenic risk.

The most favorable situation characterized with maximum permissible level of carcinogenic risk (less than 1.0E-04) was detected in Uchalinskiy district (in Burantsy village, Uchalyi city, Il'chino village), and in Baimakskiy disrict (in Halilovo and Isyanovo villages).

Population carcinogenic risk as a number of additional malignant neoplasms cases for overall population number on the examined territories amounted to 119.02 cases in Beloretskiy district (population amounts to 104,401 people); 61.04 cases, in Uchalinskiy district (72,663 people); 45.04 cases, in Abzelilovskiy district (45,042 people): 10.02 cases, in Baimakskiy district (57,283 people).

Conclusion. Water from centralized water supply sources in main cities and district centers in Bashkortostan mining regions in general conforms to sanitary and hygienic standards. Yet, quality of decentralized water sources doesn't conform to the existing requirements on some territories. The results of drinking water samples analysis revealed that in case of decentralized water supply on mining territories such contamination parameters as increased hardness, high content of iron, calcium, nitrates, as well as hexavalent chromium content in con-

centrations close to maximum permissible ones, are top water contamination parameters.

We detected high nitrates content in drinking waters taken from wells and springs on some territories. Besides, we found coliform and thermo-tolerant coliform bacteria in water taken from wells and springs used by population for household needs.

Assessment of organoleptic, non-carcinogenic and carcinogenic risks caused by drinking water consumption in some mining areas in Bashkortostan showed that water sources may really have some influence on population living conditions and health state in this region.

Population in mining areas of Bashkortostan who use decentralized water supply sources may actually run the risk of malignant neoplasms evolvement. The highest carcinogenic risk (up to 10-12 additional malignant neoplasms cases per 10,000 people) may occur on some territories of Beloretskiy district (Slantsyi and Azikeevo villages) and Abzelilovskiy district (Baimovo and Tashbulatovo villages). Carcinogenic risk which may occur on these territories is caused by increased hexavalent chromium and benzpyrene content in water. The most favorable situation with low carcinogenesis probability was forecasted In Uchalinskiy and Baimakskiy districts, in billages halilovo, Burantsyi, Il'chino and Isyanovo.

Besides, population on the examined territories may also run the risk of pathologies evolvement in blood system caused by increased nitrates, manganese, iron and lead content in water, and in cardiovascular system caused by increased nitrates content in water. We also detected significantly high (signal) hazardous indexes values which may lead to pathological changes in gastrointestinal tract, kidneys, and other organs and systems.

The obtained results coincide with other authors' research [2, 4, 5, 10, 11, 14, 15]. We should note that chemical and analytical data are not sufficient and representative enough and this fact influences the final assessment reliability; also only a part of impurities present in drinking water were included into monitoring examinations. Since risk assessment was performed as if for a maximum exposed individual (who was theoretically exposed to maximum possible impact exerted by contaminated drinking water during his lifetime), and all obtained values exceed acceptable risk levels we assume that it may be appropriate to conduct expanded research basing on data on actual exposure loads which population in mining areas in Bashkortostan may suffer from. Besides, one should detect a relative contribution made by each water supply source into risk of carcinogenic and non-carcinogenic diseases in order to create most favorable conditions for further risk management.

This research results were used to work out a system of recommendations on providing population in rural settlements with good quality drinking water, improving their social and hygienic living conditions, and reducing morbidity caused by water factor.

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SANITARY AND EPIDEMIOLOGIC ASSESSMENT OF THE SOIL QUALITY IN MOSCOW AS POSSIBLE PUBLIC HEALTH RISK FACTOR

E.E. Andreeva

Administration of the Federal Service for Supervision of Consumer Rights Protection and Human Welfare in Moscow, 4/9 Grafskiy Pereulok, Moscow, 129626, Russian Federation

The article describes the results of the sanitary-epidemiological evaluation of Moscow soil quality as a possible risk factor for injury to citizens' life and health. It presents a comparative analysis of the dynamic non-standard soil samples on the sanitary-chemical, parasitological and microbiological indicators in the Russian Federation and in Moscow. The data for the soil quality analysis in the administrative districts of Moscow are summarized. It has been demonstrated, that in the metropolis territory there is a tendency of soil quality improvement in comparison with the year 2012 (according to the sanitary-chemical parameters - by 5.64 %, microbiological – by 4.52 % and parasitological – by 0.4 %). Levels of soil chemical and microbiological contamination in Moscow for the years 2012–2014 were higher than levels in the Russian Federation by 2.43–2.71 and 1.49–2.23 times respectively. The highest proportion of soil samples, that do not meet hygienic standards for chemical indicators in 2014, both in the Russian Federation and in Moscow, was recorded in the zones of influence of the industrial enterprises, highways (RF – 10.64 % Moscow – 17.65 %) and in the residential areas (RF – 6.53 %, Moscow – 17.63 %). More than 50 % of soil samples which do not meet hygienic standards for chemical indicators in 2014, was observed in 4 of the 10 administrative districts of Moscow Central Administrative District (CAD) – 83.3 ± 36.5 %, West AD – 94.4 ± 31.7 %, North AD – 50.0 ± 25.3 %, South AD – 88.9 ± 30.8 %. By the year 2014 the priority pollutants of urban soils in Moscow were lead, zinc, chromium, cadmium, cobalt. In two districts of Moscow the proportion of poor soil samples for bacteriological parameters exceeded 50 % in 2014: South-Eastern Administrative District (54.2 ± 29.4 %) and Eastern Administrative District (75.0 ± 30.0 %). Due to the microbiological parameters the unsatisfactory samples of soil in Moscow demonstrated the excessive indicators of coliforms and enterococci indices. The proportion of soil samples exceeding hygienic standards for parasitological indices ranged from 3.3 ± 6.5 % to 5.6 ± 7.7 % in the North AD, South AD and Central AD (non-viable helminthic eggs identified).

***Key words**: soil quality, soil contamination indicators (sanitary-chemical, parasitological, microbiological), space-dynamic analysis, priority pollutants.*

According to Great Medical Encyclopedia, soil is a complex of organic and mineral compounds which emerged on the Earth's crust as a result of physical, chemical, and biological processes [2]. Soil studies are of great interest for hygienists and epidemiologists as soil matters a lot when we speak about sanitary issues of our everyday life. Soil contamination and consequent soil waters contamination lead to epidemics evolvement [15, 23]. Knowledge on soil characteristics is very important for construction, camping, laying water-supply and sewer networks, projecting cemeteries and sprinkling beds etc. Besides, close relations between soils and climate in this or that area as well as between soils and vegetation make soils studies even more important for tackling settlements hygiene issues, in particular, projecting and constructing cities and villages etc. [3, 6, 7, 16, 17, 18]. Soils are considered to be a special natural membrane (biogeomembrane) which regulates interaction between the Earth's biosphere, hydrosphere and atmosphere. Systemic analysis tells that soils is a multifunctional, heterogeneous, open, and four-phase system (solid phase, liquid phase, gaseous phase, and life forms). Taken form sanitary point of view, soils can cause population

Elena E. Andreeva – Candidate of Medical Sciences, head, chief state sanitary doctor of the city of Moscow (e-mail: uprav@77.rospotrebnadzor.ru; tel.: +7 (495) 621-70-76).

endemic diseases; and soil contamination caused by anthropogenic activities leads to additional morbidity cases, both of infectious and non-infectious nature [1, 4, 5, 9, 11-14, 19-22]. As per data provided by the Federal Service for Surveillance over Consumer Rights Protection and Human Well-being [8, 10] soil quality tended to improve in the Russian Federation in 2014 (in comparison with 2012) as per sanitary-chemical, microbiological and parasitological parameters. The same trend also occurred in Moscow (table 1).

The share of examined soil samples not conforming to hygienic standards as per sanitary-chemical parameters decreased by 1.47% in the RF (in comparison with 2012), and by 5.64% in Moscow (table 2). However, level of soil chemical contamination in Moscow in 2012-2014 was 2.43-2.71 times higher than in the RF. The level of soil microbiological contamination was also 1.49-2.23 times higher in Moscow than in the RF over the last 3 years. We should note that the share of examined soils samples not conforming to hygienic standards as per parasitological parameters was 1.41-1.94 times lower in Moscow than in the RF on average (table 1).

Microbiological contamination is a parameter which defines soil quality on the territories of children facilities and children playgrounds. In Moscow in 2012-2014 the level of soil microbiological contamination on the territories of children facilities and children playgrounds was 2.16-3.67 times higher than in the RF on average. And its value remained high in spite of the fact that the share of soil samples not conforming to hygienic standards as per microbiological parameters decreased by 1.24 times in the RF and by 1.84 times in Moscow (table 2).

The specific weight of soil samples taken on the territories of children facilities and children playgrounds not conforming to hygienic standards as per sanitary-chemical parameters decreased by 1.07 times in the RF on the whole and by 1.3 times in Moscow (table 2).

The greatest specific weight of soil samples not conforming to hygienic standards as per sanitary-chemical parameters in 2014, both in the RF on the whole and in Moscow, was detected in zones influenced by industrial enterprises, roads and motorways (10.64% in the RF, 17.65% in Moscow), and on areas fir for development (6.53% in the RF, 17.63% in Moscow). At the same time the share of soil samples not conforming to hygienic standards as per sanitary-chemical parameters decreased in 2014 (in comparison with 2012) by 1.05 times in the RF and by 2.88 in Moscow (figure 1).

Table 1

Share of examined soil samples not conforming to hygienic standards, %

Parameters	2012		2013		2014	
	The RF	Moscow	The RF	Moscow	The RF	Moscow
Sanitary-chemical	8,75 ± 0,20	23,71 ± 3,66	8,60 ± 0,20	20,87 ± 3,06	7,28 ± 0,19	18,07 ± 2,77
Microbiological	9,33 ± 0,19	16,35 ± 1,55	9,04 ± 0,18	20,23 ± 1,44	7,9 ± 0,17	11,83 ± 1,33
Parasitological	1,68 ± 0,07	1,19 ± 0,32	1,61 ± 0,07	0,83 ± 0,23	1,48 ± 0,06	0,79 ± 0,26

Table 2

Share of examined soil samples taken on the territories of children facilities and children playgrounds and not conforming to hygienic standards, %

Parameters	2012		2013		2014	
	The RF	Moscow	The RF	Moscow	The RF	Moscow
Sanitary-chemical	4,32 ± 0,26	14,38 ± 4,15	3,72 ± 0,24	16,67 ± 3,96	4,02 ± 0,25	11,04 ± 2,94
Microbiological	7,53 ± 0,28	27,61 ± 4,80	7,24 ± 0,27	15,54 ± 3,03	6,03 ± 0,25	15,01 ± 3,17
Parasitological	0,92 ± 0,07	0,43 ± 0,28	0,87 ± 0,07	0,43 ± 0,27	0,88 ± 0,07	0,45 ± 0,08

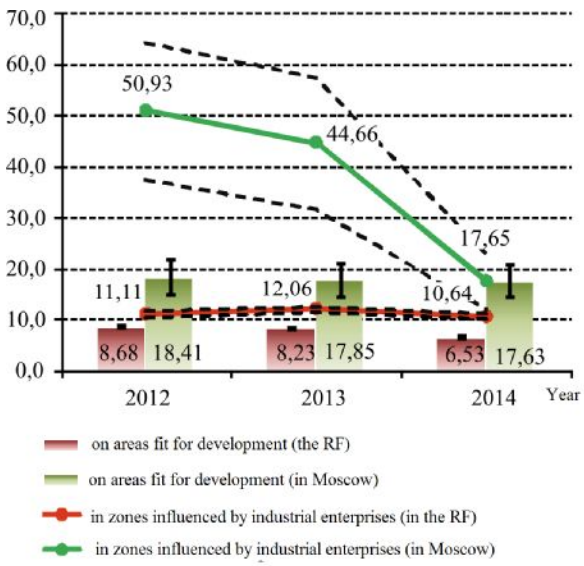

Figure 1. Share of examined soil samples not conforming to hygienic standards as per sanitary-chemical parameters, in the RF and in Moscow, %

Mercury, lead and cadmium were the main metals causing chemical contamination of soils in the RF. In 2012-2014 share of soils samples not conforming to hygienic standards as per heavy metals content (including lead and cadmium) tended to decrease both in the RF on the whole and in Moscow (table 3).

In 2014 specific weight of samples not conforming to hygienic standards as per heavy metals content decreased (in comparison with 2012) by 1.18 times in the RF (by 1.06 times in Moscow), including lead, by 1.4 times (by 1.61 times in Moscow), cadmium, by 1.6 times (by 1.65 times in Moscow). There were no soils samples not conforming to hygienic standards as per mercury content detected in Moscow either in 2012 or in 2014. 0.33% of soil samples in the RF contained mercury in concentrations exceeding maximum permissible one.

In 2014 specific weight of samples not conforming to hygienic standards as per heavy metals content decreased (in comparison with 2012) by 1.18 times in the RF (by 1.06 times in Moscow), including lead, by 1.4 times (by 1.61 times in Moscow), cadmium, by 1.6 times (by 1.65 times in Moscow). There were no soils samples not conforming to hygienic standards as per mercury content detected in Moscow either in 2012 or in 2014. 0.33% of soil samples in the RF contained mercury in concentrations exceeding maximum permissible one.

We should note that, in spite of all the detected positive trends in soils quality as per sanitary-chemical parameters, soils contamination with heavy metals is higher in Moscow than in the RF on average. Thus, in 2014, a share of soil samples not conforming to hygienic standards as per heavy metals content was 3.64 times higher in Moscow than in the RF (table 3).

311 soils samples were examined in 2014 as per sanitary-chemical parameters (331 samples in 2013); 313 soils samples, as per microbiological parameters (341 samples in 2013); 334 soil samples, as per parasitological parameters (576 samples in 2013). On the whole, 958 soils samples were taken for examination in 2014; 198 samples out of the total number didn't conform to hygienic standards (table 4).

In 2014 in Moscow 119 soils samples didn't conform to hygienic standards as per sanitary-chemical parameters (38.3±6.9%); 75 soils samples, as per microbiological parameters (24.0±5.4%); 4 soil samples, as per parasitological parameters (1.2±0.7%). In 2013 the corresponding figures were 89 samples as per sanitary-chemical parameters (26.9±5.6%), 85 samples as per microbiological parameters (24.9±5.3%), 8 samples as per parasitological parameters (1.4±1.0%).

In 2014 more than 50% of soil samples not conforming to hygienic standards as per sanitary-chemical parameters were taken on the territory of 4 out of 10 Moscow administrative districts: 83.3±36.5% in TsAD[1], 94.4±31.7% in ZAD, 50.0±25.3% in SAD,

[1] here and further on: TsAD is Tsentralniy AD, ZAD is Zaoadniy AD, SAD is Severniy AD, YuAD is Yuzhniy AD, VAD is Vostochniy AD, ZelAD is Zelenogradskiy AD, YuZAD is Yugo-Zaoadniy AD, YuVAD is Yugo-Vostochniy AD, SVAD is Severo-Vostochniy AD, SZAD is Severo-Zaoadniy AD.

88.9±30.8% in YuAD (table 4). A share of unsatisfactory samples as per bacteriological parameters exceeded 50% only in two administrative districts in Moscow, namely YuVAD (54.2±29.4%) and VAD (75.0±30.0%). This parameter didn't exceed 46.7±24.4% in other administrative districts. In ZelAD, YuAD and SVAD all the examined soil samples conformed to hygienic standards as per microbiological parameters. A share of soil samples not conforming to hygienic standards as per parasitological parameters varied from 3.3±1.5% to 5.6±2.7% in SAD, YuAD and TsAD. There were no unsatisfactory soil samples as per parasitological parameters registered in all other administrative districts in Moscow (table 4).

Analysis of soil contamination dynamics in Moscow revealed that on the whole specific weight of samples not conforming to hygienic standards as per sanitary-chemical, microbiological and parasitological parameters decreased over 2012-2014 (table 5).

A share of soil samples not conforming to hygienic standards as per sanitary-chemical parameters decreased in 2014 by 0.4% in comparison with 2012. Specific weight of unsatisfactory samples as per sanitary-chemical parameters decreased in 5 administrative districts in Moscow, namely VAD, SAD, YuBAD, SVAD, and TsAD. A share of samples not conforming to hygienic standards increased in 3 administrative districts, namely YuAD, YuZAD, and ZAD. And there were no soil samples not conforming to hygienic standards as per sanitary-chemical parameters registered in 2 administrative districts (ZelAD and SZAS). In 2014, just like in previous years, lead, zinc, chrome, cadmium, and cobalt, were priority contaminants of Moscow city soils.

Table 3

Share of soil samples not conforming to hygienic standards as per content of certain heavy metals, %

Chemical substances	2012		2013		2014	
	The RF	Moscow	The RF	Moscow	The RF	Moscow
Heavy metals, including:	6,52 ± 0,19	21,80 ± 3,55	6,26 ± 0,18	19,55 ± 3,15	5,50 ± 0,17	20,05 ± 3,20
– mercury	0,25 ± 0,05	0,00	0,17 ± 0,04	1,34 ± 0,88	0,33 ± 0,05	0,00
– lead	2,80 ± 0,13	9,88 ± 2,40	2,06 ± 0,11	5,76 ± 1,72	2,00 ± 0,11	6,13 ± 1,77
– cadmium	1,09 ± 0,08	1,98 ± 1,07	0,90 ± 0,07	1,48 ± 0,88	0,68 ± 0,07	1,20 ± 0,78

Table 4

Soil contamination parameters in populated areas of Moscow as per social-hygienic monitoring data in 2014

AD	Sampling points number	Contamination parameters								
		Sanitary-chemical			Microbiological			Parasitological		
		Samples number	Not conforming to standards		Samples number	Not conforming to standards		Samples number	Not conforming to standards	
			units	%		units	%		units	%
VAD	16	16	0	0	32	24	75.0±30.0	32	0	0
SAD	15	30	15	50.0±25.3	30	14	46.7±24.4	30	1	3.3±1.5
ZelAD	5	10	0	0	10	0	0	10	0	0
YuAD	18	36	32	88.9±30.8	36	0	0	36	2	5.6±2.7
YuZAD	12	77	12	15.6±8.8	63	9	14.3±9.3	84	0	0
ZAD	18	36	34	94.4±31.7	36	5	13.9±12.2	36	0	0
YuVAD	12	24	4	16.7±16.3	24	13	54.2±29.4	24	0	0
SVAD	17	34	2	5.9±8.1	34	0	0	34	0	0
SZAD	11	24	0	0	24	2	8.3±3.5	24	0	0
TsAD	12	24	20	83.3±36.5	24	8	33.3±23.1	24	1	4.2±2.2
Total	136	311	119	38.3±6.9	313	75	24.0±5.4	334	4	1.2±0.7

Table 5

Dynamics of changes in soil contamination parameters in populated areas of Moscow over 2012-2014

AD	A share of soils samples not conforming to hygienic standards, %								
	Sanitary-chemical examination			Microbiological examination			Parasitological examination		
	2012	2013	2014	2012	2013	2014	2012	2013	2014
VAD	56.3±36.7	0	0	34.4±20.3	81.3±31.2	75.0±30.0	3.1±6.1	3.1±6.1	0
SAD	63.3±28.4	73.3±30.6	50.0±25.3	63.3±28.4	10±11.3	46.7±24.4	3.3±6.5	6.7±9.2	3.3±1.5
ZelAD	0	0	0	0	0	0	0±0	0	0
YuAD	11.1±10.9	25±16.3	88.9±30.8	0	13.9±12.2	0	5.6±7.7	2.8±5.4	5.6±2.7
YuZAD	12.5±14.1	20±9.2	15.6±8.8	87.5±37.4	11.9±7.4	14.3±9.3	0±0	0	0
ZAD	63.9±26.1	47.2±22.4	94.4±31.7	47.2±22.4	58.3±24.9	13.9±12.2	0±0	2.8±5.4	0
YuVAD	37.5±24.5	2.9±5.8	16.7±16.3	29.2±21.6	32.4±19.1	54.2±29.4	0±0	0	0
SVAD	29.4±18.2	17.6±14.1	5.9±8.1	14.7±12.9	2.9±5.8	0	0±0	0	0
SZAD	0	0	0	0	9.1±12.6	8.3±3.5	0±0	0	0
TsAD	91.7±38.3	69.6±34.1	83.3±36.5	25±20	26.1±20.9	33.3±23.1	4.2±8.2	13±14.7	4.2±2.2
TOTAL	38.7±7.6	26.9±5.6	38.3±6.9	31.6±6.7	24.9±5.3	24.0±5.4	1.9±1.7	1.4±1	1.2±0.7

Specific weight of soil samples not conforming to hygienic standards as per microbiological agents content decreased by 7.6% in 2014 in comparison with 2012. The share of unsatisfactory soils samples as per microbiological parameters went down in YuZAD, ZAD, and SVAD; their number grew in VAD, SAD, YuVAD, SZAD, and TsAD. The share of unsatisfactory samples remained the same in ZelAD and YuAD.

Soil samples unsatisfactory as per microbiological parameters had increased content of colon bacillus group bacteria and high enterococcus index, but no pathogenic germs (including salmonella) were detected.

A share of soil samples not conforming to hygienic standards as per parasitological parameters decreased by 0.72% in Moscow in 2014 in comparison with 2012. Decrease in soil parasitological contamination was detected in VAD. There were no changes in this parameter detected in any other administrative district.

Soil quality deviating from hygienic standards as per parasitological parameters occurred in single instances when unviable helminth eggs were detected.

So, hygienic characteristics of soil contamination in Moscow revealed that:

 soil quality tended to improve both in Moscow and in the RF on the whole in 2014 (in comparison with 2012) as per sanitary-chemical (by 1.47% in the RF, by 5.64% in Moscow), microbiological (by 1.43% in the RF, by 4.52% in Moscow), and parasitological parameters (by 0.2% in the RF, by 0.4% in Moscow);

 the level of soil microbiological contamination in Moscow exceeded average country level by 1.49-2.23 times over the last three years:

 the share of examined soil samples not conforming to hygienic standards as per parasitological parameters was 1.41-1.94 times lower in Moscow than in the RF on average;

 the level of soil chemical contamination in Moscow was 2.43-2.71 times higher than in the RF in 2012-2014;

 the biggest specific weight of samples not conforming to hygienic standards as per sanitary-chemical parameters in 2014 both in the RF and in Moscow was registered in zones influenced by industrial enterprises, roads and motorways (10.64% in the RF, 17.65% in

Moscow) and on areas fit for development (6.53% in the RF, 17.63% in Moscow);

 mercury, lead, and cadmium are priority metals influencing soil chemical contamination in the RF. In 2014 specific weight of samples not conforming to hygienic standards as per heavy metal contamination, decreased by 1.18 in the RF in comparison with 2012 (it decreased by 1.06 in Moscow); it decreased by 1.4 times in respect of lead (by 1.61 in Moscow) and by 1.6 times in respect of cadmium (by 1.65 in Moscow);

 more than 50% of soil samples not conforming to hygienic standards as per sanitary-chemical parameters were detected in 4 out of 10 administrative districts in Moscow; the figures were 83.3±36.5% in TsAD, 94.4±31.7% in ZAD, 50.0±25.3% in SAD, 88.9±30.8% in YuAD;

 a share of unsatisfactory samples as per bacteriological parameters exceeded 50% in two administrative districts in Moscow in 2014, namely YuVAD (54.2±29.4%) and VAD (75.0±30.0%);

 a share of samples not conforming to hygienic standards as per parasitological parameters varied from 3.3±6.5% to 5.6±7.7% in SAD, YuAD and TsAD;

 lead, zinc. chrome, cadmium, and cobalt were main contaminants of city soils in 2014;

 soil samples not conforming to hygienic standards as per microbiological parameters in Moscow had increased number of colon bacillus group bacteria and high enterococcus index;

 soil quality deviating from hygienic standards as per parasitological parameters was a rare case and occurred only when unviable helminth eggs were detected.

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EXPERIMENTAL MODELS AND INSTRUMENTAL SURVEYS FOR RISK ASSESSMENT IN HYGIENE AND EPIDEMIOLOGY

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IMPACT OF SILICA DIOXIDE NANOPARTICLES ON THE MORPHOLOGY OF INTERNAL ORGANS IN RATS BY ORAL SUPPLEMENTATION

N.V. Zaitseva[1], M.A. Zemlyanova[1,2,4], V.N. Zvezdin[1,4], A.A. Dovbysh[1], I.V. Gmoshinskiy[3], S.A. Khotimchenko[3]

[1]Federal Scientific Center for Medical and Preventive Health Risk Management Technologies, 82 Monastyrskaya Str., Perm, 614045, Russian Federation
[2]Perm National Research Polytechnic University, 29 Komsomolskiy Ave., Perm, 614990, Russian Federation
[3]Federal research centre of nutrition and biotechnology, 2/14 Ustinskiy Proezd, Moscow, 109240, Russian Federation
[4]Perm State National Research University, 15 Bukireva Str., Perm, 614990, Russian Federation

The object of the study was amorphous silica dioxide (SiO_2), which is widely used as a food additive (E551), a subsidiary component in pharmaceutical preparations, perfumery and cosmetic products etc. In the specification of JECFA silica dioxide does not have information about the size of its particles, which allows the use of fine amorphous SiO_2, obtained by gas phase hydrolysis of tetrachlorosilane as a food additive. This material, known as the "Aerosil", is characterized by the size of the specific surface area of 300–380 m^2/g and the size of its relatively weakly agglomerated particles of 6–30 nm, i.e., it is a nanomaterial. In the biological model the morphological changes in organs and tissue systems on oral supplementation of nanoscale particles of silica dioxide were studied. Wistar male rats were given nanosized silica dioxide with specific surface area of 300 m^2/g and primary nanoparticle size on the basis of data of electrical, atomic-powered microscopy, and dynamic light scattering in the range of 20–60 nm during 92 days. Light microscopic morphological examination of organs of rats showed a relatively mild inflammation in the structure of parenchymal organs (liver, kidney), not showing a certain dose-dependent nanoparticles. The most pronounced changes were in ileum morphology, consisting of a massive lymph macrophage and eosinophil infiltration of villi, without any apparent violation of their epithelial layer structure, which indirectly indicates the absence of violations of the barrier function of the intestinal epithelium. At the maximum dose of 100 mg/kg bw, the increased immune response was the most significant in the wall of the ileum. The results indicate the potential risks to human

Nina V. Zaitseva – Member of RAS, Doctor of Medical Sciences, Professor, Director (e-mail: znv@fcrisk.ru; tel.: +7 (342) 233-11-25).

Marina A. Zemlyanova – Doctor of Medical Sciences, Professor, head of the department of biochemical and cytogenetic diagnostic methods, Professor of Human Ecology and Life Safety (e-mail: zem@fcrisk.ru; tel.: +7 (342) 236-39-30).

Vasiliy N. Zvezdin – PhD, Head of the Health Department of Children and Adolescents (e-mail: zvezdin@fcrisk.ru; tel.: +7 (342) 237-25-34).

Anastasiya A. Dovbysh – Laboratory toxicologist metabolism and pharmacokinetics (e-mail: dovnastja@yandex.ru; tel.: +7 (342) 236-39-30).

Ivan V. Gmoshinskiy – Doctor of Biological Sciences, leading researcher of the Laboratory of Food Toxicology and Nanotechnology safety assessment (e-mail: gmosh@ion.ru; tel.: +7 (495) 698-53-71).

Sergey A. Khotimchenko – MD, Professor, Head of Laboratory of food toxicology and safety assessment of nanotechnology, Acting Deputy Director for Science, (e-mail: hotimchenko@ion.ru; tel.: +7 (495) 698-52-35).

health when using SiO_2 having a specific surface area of 300 m^2/g or higher in the composition of food products as a food additive.

***Key words**: nanoparticles, silica dioxide, morphological studies, oral supplementation, subacute toxicity, health risks.*

Amorphous silicon dioxide (SiO2) is widely used as a food additive (E551) as well as accessory ingredient in pharmaceuticals, perfumes and cosmetics. JFCFA specification dedicated to silicon dioxide [25] doesn't contain any information on its particles' size and it allows using superfine amorphous SiO2, obtained via gas-phase hydrolysis of tetrachlorsilane, as a food additive. This material well-known as "Aerosil" has specific surface area equal to 300-380 m2/g, and its relatively feebly agglomerated particles are 6-30 nm in size so we can name it a nanomaterial (NM).

The necessity to assess NM safety and health risks is justified in Resolution issued by Chief Sanitary Inspector of the RF No. 54 dated July 23, 2007 "On surveillance over products obtained via nanotechnologies and containing nanomaterials" and Rospotrebnadzor information letter "On surveillance over manufacturing and turnover of products containing nanomaterials" [2, 6].

Preliminary assessment of a degree at which silicon dioxide nanoparticles may be hazardous according to the existing Methodical Guidelines 1.2.2522-09 implies at moderate potential hazard of this nanomaterial. This fact requires a profound toxicological and hygienic study of this material in tests in vivo using laboratory animals and applying a whole set of integral, morphological, biochemical and other toxicity markers.

The purpose of this work was to study the influence exerted by nano-sized SiO2 on morphology of rats' internal organs at oral introduction during 92 days.

Data and methods. We used high-disperse amorphous SiO2 obtained from "Silika" LLC (Dolgoprudniy city, Moscow region, Russia) in our work; the material is sold under commercial name "Orisil 300" and corresponds to State Standard 14922-77. It is light white powder which, under dispersing with ultrasound in water, turns into opalescent colorless colloidal solution; the solution remains stable for not less than 2 days. Specific surface area of the product, detected via technique of inert gases adsorption isotherms, amounted to 300 m2/g as per the manufacturer's data. Specialists at "Scientific Research Institute for Nutrition" and "Biochemistry Institute named after A.N. Bach" accomplished some studies of the nanomaterial using transmission electron microscopy techniques, atomic-force microscopy and dynamic light scattering [8]. The characteristics drawn by them revealed (Figure 1), that a dry product contains mostly primary particles agglomerates sized from 5 to 100 nanometers. Analysis of particles size distribution in ultrasound-treated water suspension in 1% concentration as per mass showed that the prevailing nanoparticles fraction had average numeric hydrodynamic diameter equal to 6.6±32.1 nanometers, 90-th size percentile was 91.7 nanometers. At the same time a share of particles with diameter exceeding 100 nanometers was below 10% of the total particles number.

All the work with animals was performed in conformity with The Guide for the Care and Use of Laboratory Animals (ILAR, DELS) and Laboratory Practice Rules [5, 16]. The research was accomplished in accordance with guidelines on nanomaterials safety assessment [4]. The experiment was performed on 75 Wistar male rats with initial body weight equal to 80 grams obtained from "Stolbovaya" nursery. The animals received balanced semi-synthetic nutrition during the whole experiment. They were placed in cages, 3 animals in each, and had free unlimited access to food and water. At the beginning of the experiment the rats were randomly divided into 5 groups with the same quantity of animals (15) in each, the only condition being analogical initial average body weight. We

introduced a carrier (deionized water) into animals from the 1st (control) group. Rats from groups 2, 3, 4 and 5 received nano-sized SiO2 in the form of ultrasound-treated suspension in deionized water (treatment period was 5 minutes, frequency equal to 44 kHz, power being 1 W/cm3). During the first 30 days the nanomaterial was introduced via gastric tube; later on SiO2 suspension was added to the animals' food for the following 62 days; the dose was calculated basing on the quantity of food eaten. Introduced SiO2 dose in groups 2, 3, 4 and 5 amounted to 0.1, 1.0, 10 and 100 mg/kg of body weight correspondingly. On the 93th day the animals were taken out of the experiment via dehematizing from postcava under ether anesthesia. The selected samples of internal organs (liver, kidneys, and ileum) were instantly placed into fixing fluid (3.7% formaldehyde solution in 0.1M sodium-phosphate poiser pH 7.00±0.05) and transported to the laboratory for further examination.

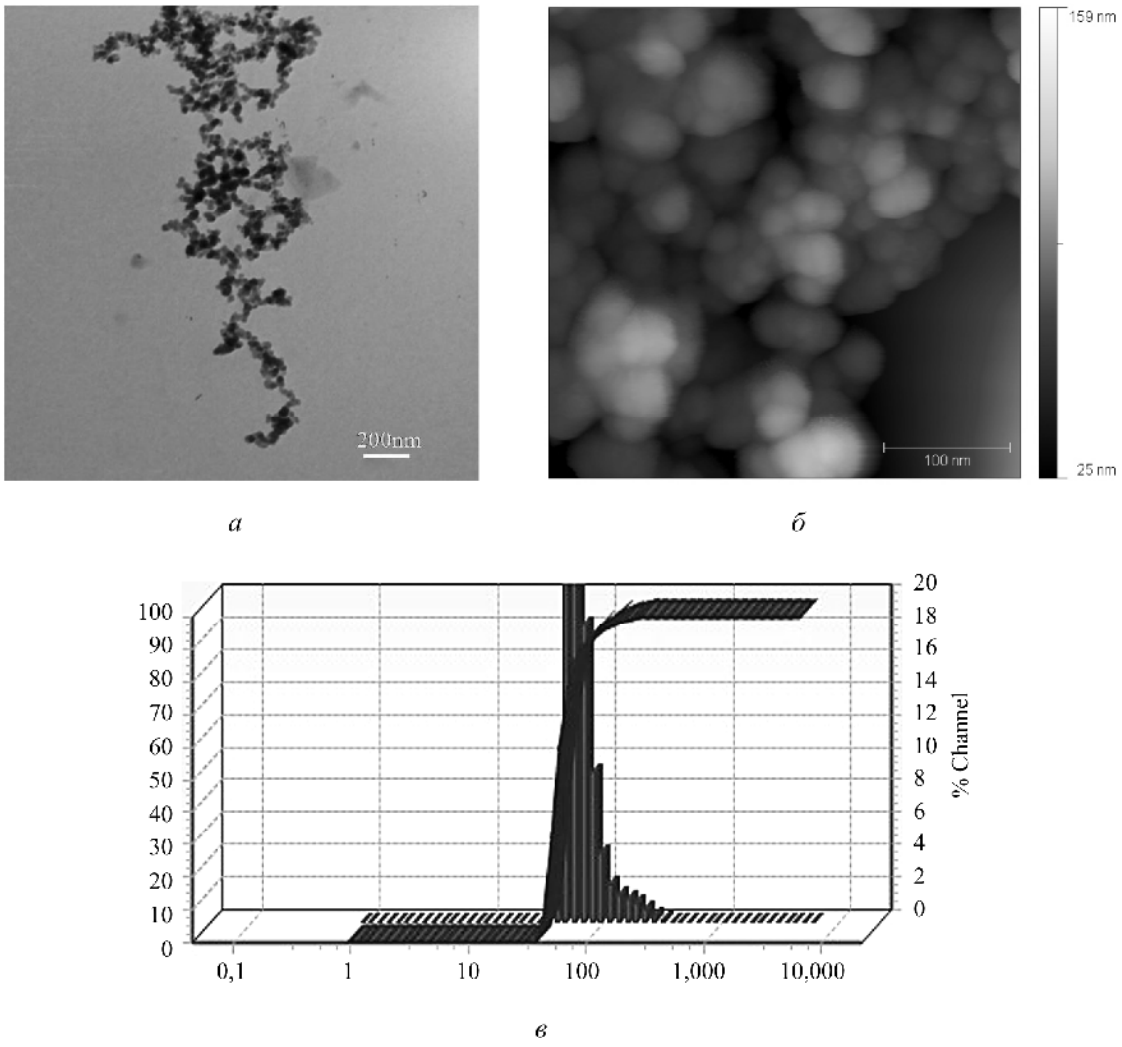


Figure. 1. Amorphous silicon dioxide "Orisil-300" particles size: a) is obtained via electronic microscopy (JEM-100CX microscope, JEOL, Japan), sample microscopy without ultrasound treatment; б) is obtained via atomic-force microscopy (SmartSPM microscope, AIST-NT, Russia), sample microscopy without ultrasound treatment; в) is obtained via dynamic light scattering technique (Nanotrack Wave device, Microtrack Inc., USA), distribution as per particles size of a sample treated with sound. Taken from work [5] with the authors' consent.

Histological specimens preparation included organs' parts dehydration in alcohols with ascending concentration, impregnation with chloroform and paraffin in «Excelsior ES» automatic histological processor (Thermo Scientific, Germany). Then the samples were embedded in homogenized paraffin medium «Histomix» [1] at «Histo Star» block embedding station (Thermo Scientific, Germany). Paraffin sections with 3-4 μm width were made with the use of «JUNG SM 2000R» sliding microtome (Leica, Germany) and then painted as per conventional technique [3] with hematoxylin and eosin in «Varistain Gemini ES» panting robot (Thermo Scientific, Germany). The obtained microslides were studied with the use of «MEI-JI» light optical microscope (Techno, Japan) at magnification equal to ×50, ×100, ×200, ×400, ×800, ×1000. Microphotos were made with «Microscopy VISION» camera (VISION, Canada). Not less than 9 microslides were made out of each organ. The total number of analyzed microslides (sections) of organs amounted to 400.

Results and discussion. The results of internal organs examination performed on all the animals from group 1 (control group) revealed that there was persistent hyperplasia of ileum lymphoid tissue with secondary follicles formation. Feebly apparent lymphoid infiltration and solitary eosinophils were detected in hepatoportal tracts in some microslides. No visible morphologic changes were detected in the animals' kidneys. On the whole, morphological state of internal organs taken out of the rats from control group corresponded to the physiological standard for animals of such sex and age.

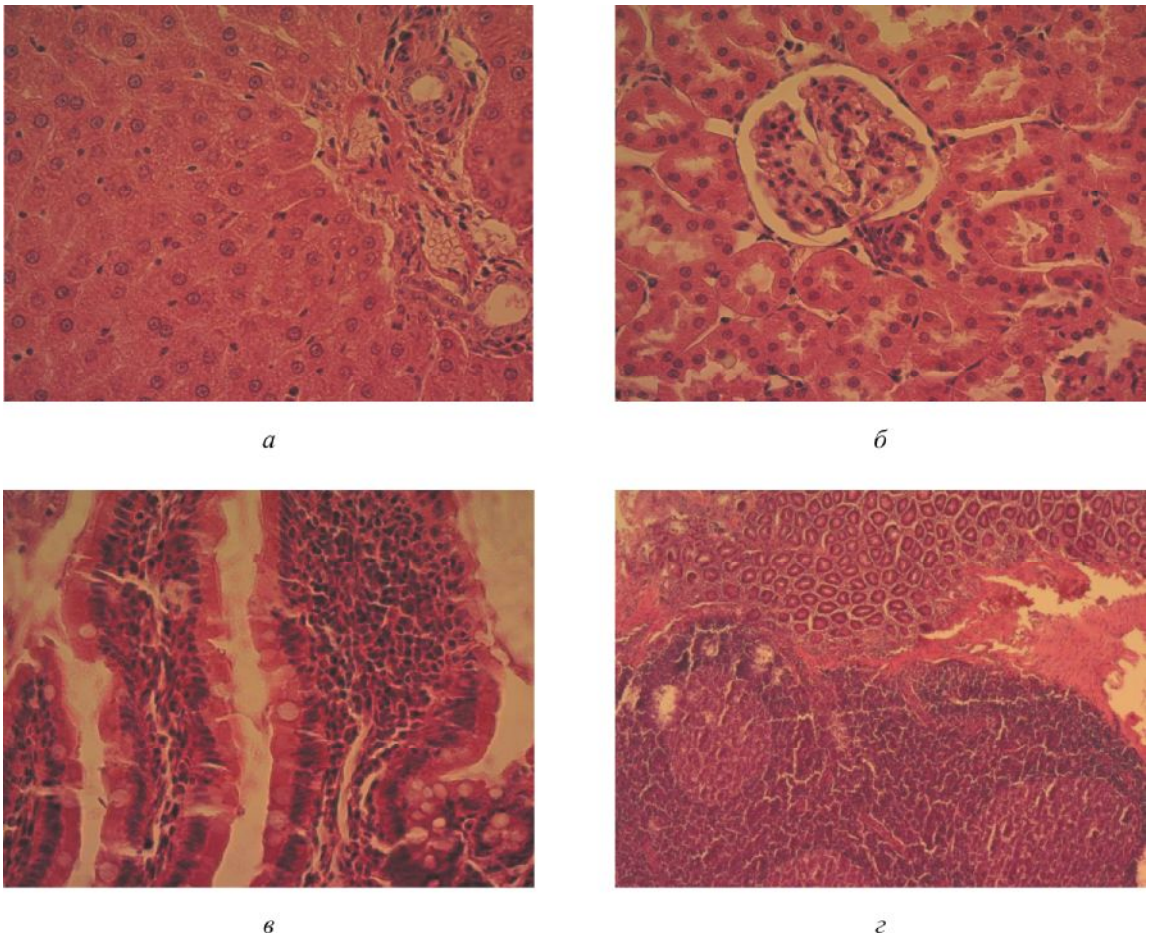


Figure 2. Representative microphotos of a rat from group 1 (control) (painted with hematoxylin and eosin), magnification ×200 (а, г), ×400 (б, в): *а* is liver, б is kidneys; *в, г* is ileum

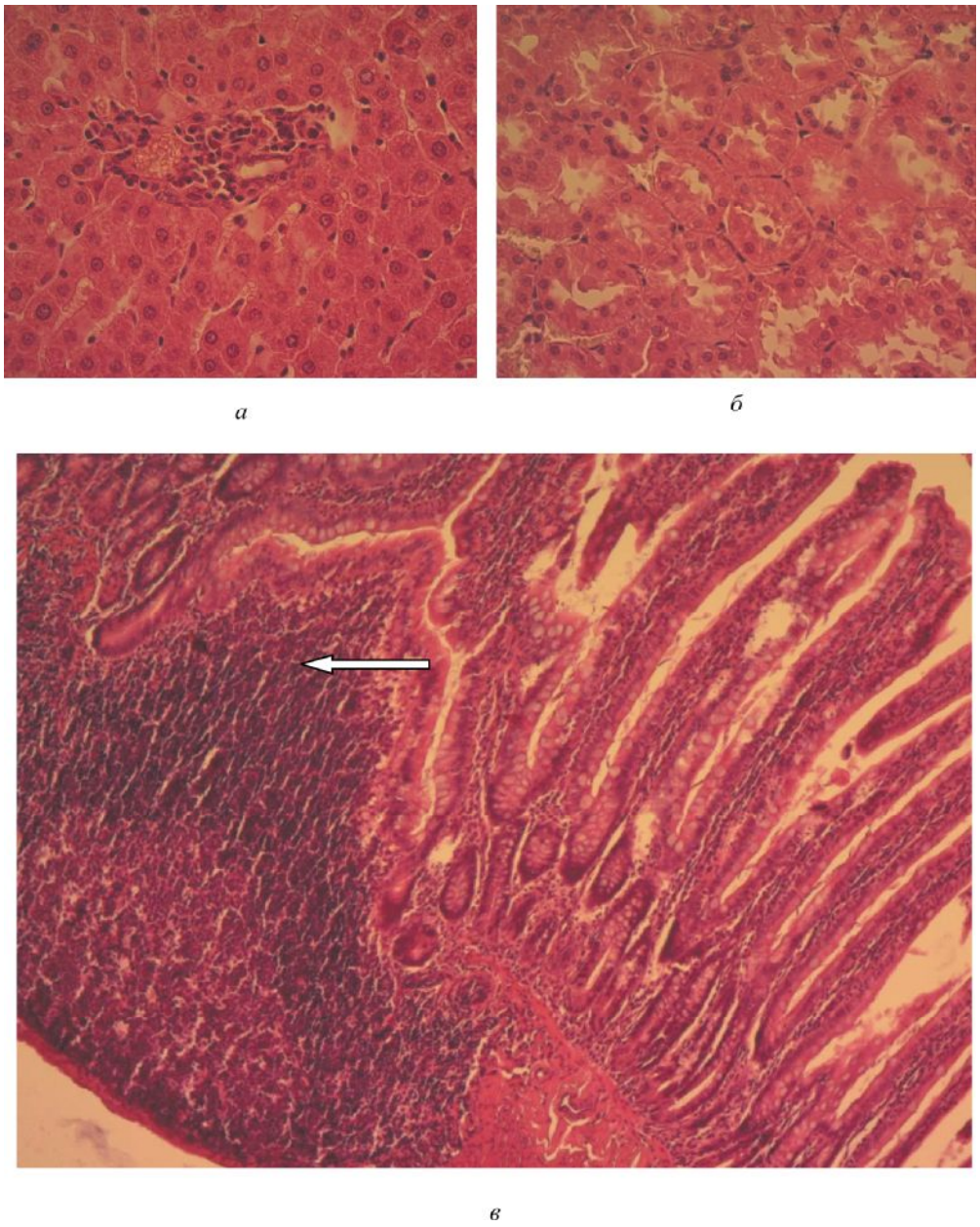


Figure 3. Representative microphotos of a rat from group 2 (silicon dioxide, 0,1 mg/kg b.w.) (painted with hematoxylin and eosin), magnification ×200 (а, б); ×400 (в): а is liver; б is kidneys; в is ileum. Arrow points at internodule lymphoid tissue.

Representative microphotos of liver, kidney and ileum section of the rats from control group are shown in Figure 2.

Animals from group 2 (silicon dioxide dose equal to 0.1 mg/kg of body weight) had feebly apparent focal dust-like and atomized lipid parenchymatous degeneration and eosinophilia of portal tracts infiltrate in their liver (Figure 3a).

Feebly apparent mesangial cells proliferation was detected in some glomerules (up to 6 in a lobule) without any increase in mesangial matrix volume; there was also focal swelling of cells in external leaf of nephron capsule (Figure 3b). We detected large trapezoidal cells with considerable eosinophilic granules in apical part and dark nucleus in basal sections - Paneth cells - in the base of ileum mucous tunic crypts. Solitary lymph nodes were large with big reactive centers and wide cellular mantle zones; they penetrated into submucous layers from proper layer. Peyer's plaques

came from proper layer of mucous tunic into submucous layer. Bowel lumen was greatly narrowed in the zones where large Peyer's plaques were located. Lymph nodes between villi evaginated mucous tunic into bowel lumen in a form of a cupula which was covered with low epithelial cells with a great quantity of lymphocytes and macrophages (Figure 3c). There was a slight edema, moderate infiltration from eosinophils, macrophages, lymphocytes and plasma cells, in submucous layer.

Liver hepatocytes in animals from group 3 (silicon dioxide dose equal to 1 mg/kg of b.w.) were in the state of focal dust-like and atomized lipid degeneration; there were numerous small transparent drops with sharp contours in cells cytoplasm and some hepatocytes with two nucleuses were detected. We observed infiltration of lymphocytes, macrophages, and plasma cells with solitary eosinophils admixture in portal tracts and sinusoids (Figure 4a).

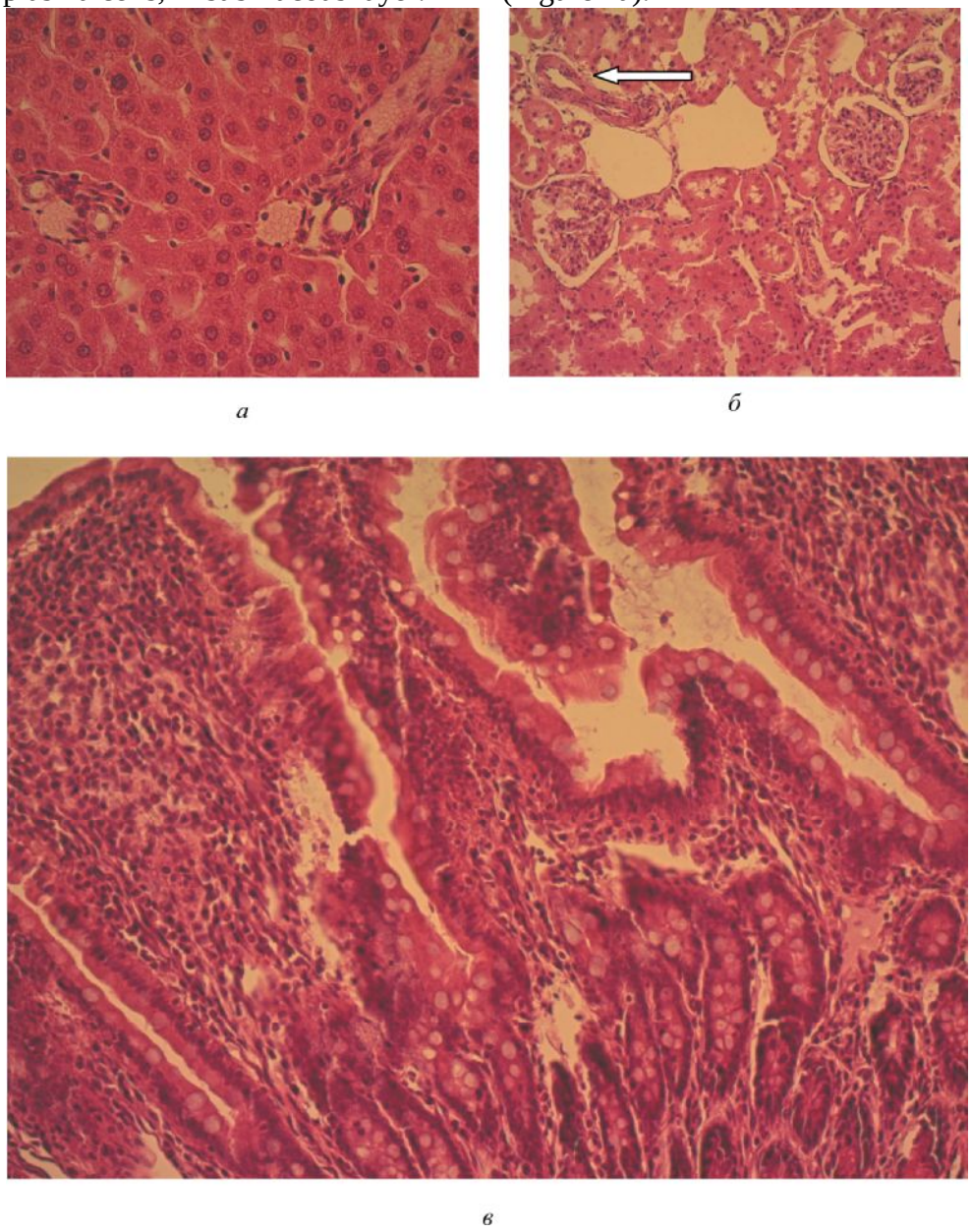
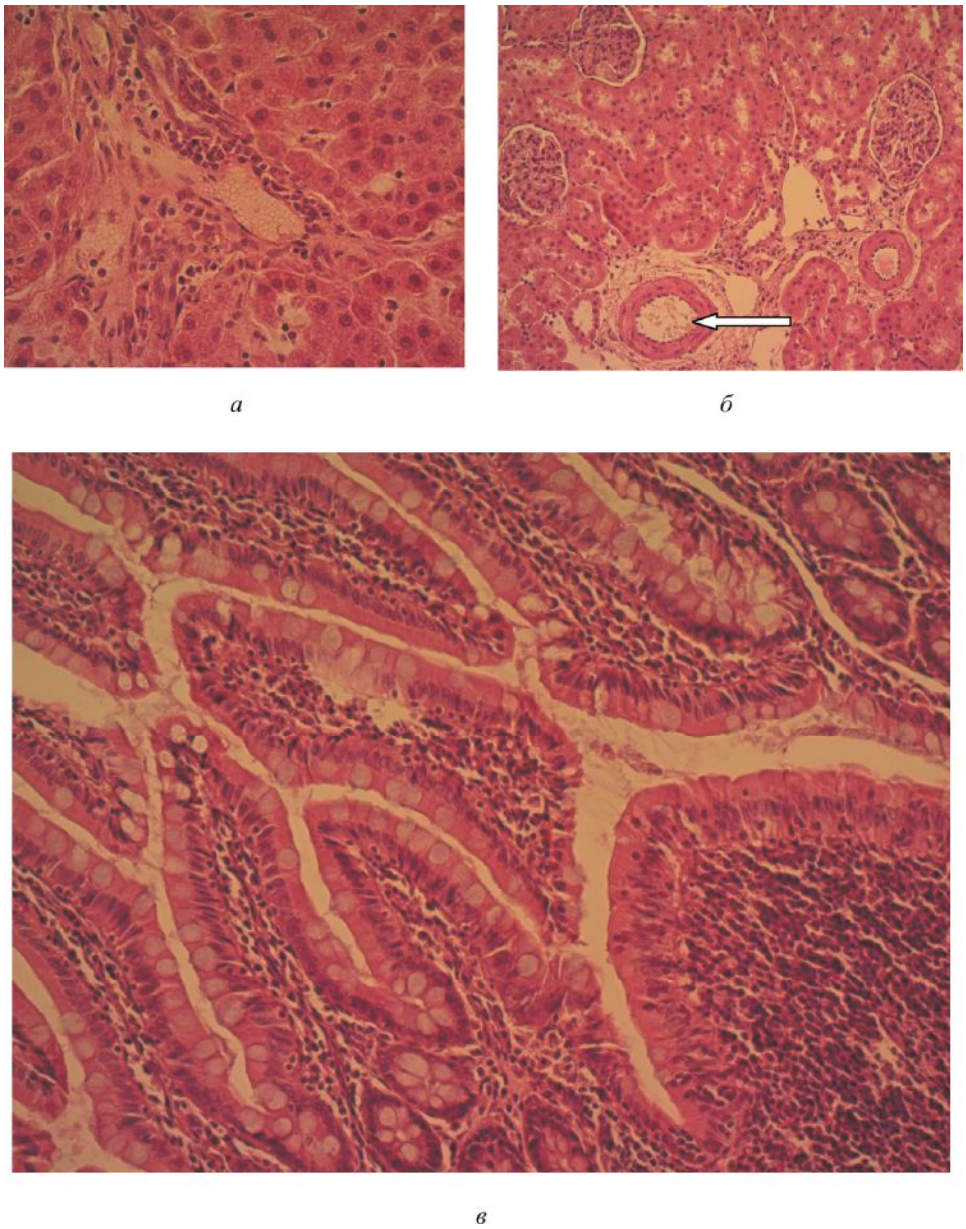


Figure 4. Representative microphotos of a rat from group 3 (silicon dioxide, 1.0 mg/kg b.w.) (painted with hematoxylin and eosin), magnification ×200 (а, б); ×400 (в): а is liver; б is kidneys, arrow points at a vein; в is ileum.

There were no signs of mesangial cells proliferation and proliferation of capsule external leaf cells in kidneys of animals from this group. Just a slight number of glomerules had focal swelling of capsule external leaf cells (Figure4b).

Villi in ileum mucous tunic were of various form and width due to uneven edema and cellular infiltration from lymphocytes, macrophages, and numerous eosinophils (Figure 4c).

Bunches of lymphocytes, macrophages, plasma cells, and numerous eosinophils occurred in proper layer. There were large bunches of Paneth cells in the base of crypts. Solitary follicles and Peyer's plaques follicles were large with big reactive centers and wide mantle zones converting into internodal lymphoid tissue. Follicles from mucous layer penetrated into submucous layer and made muscular tunic substantially thinner. Crypts in Peyer's plaques view were not deep or they were even absent; villi were short and irregular-shaped.



а *б*

в

Figure 5. Representative microphotos of a rat from group 4 (silicon dioxide, 10 mg/kg b.w.) (painted with hematoxylin and eosin), magnification ×200 (а, б); ×400 (в): а is liver; б is kidneys, arrow points at an artery; в is ileum, arrow points at Paneth cells.

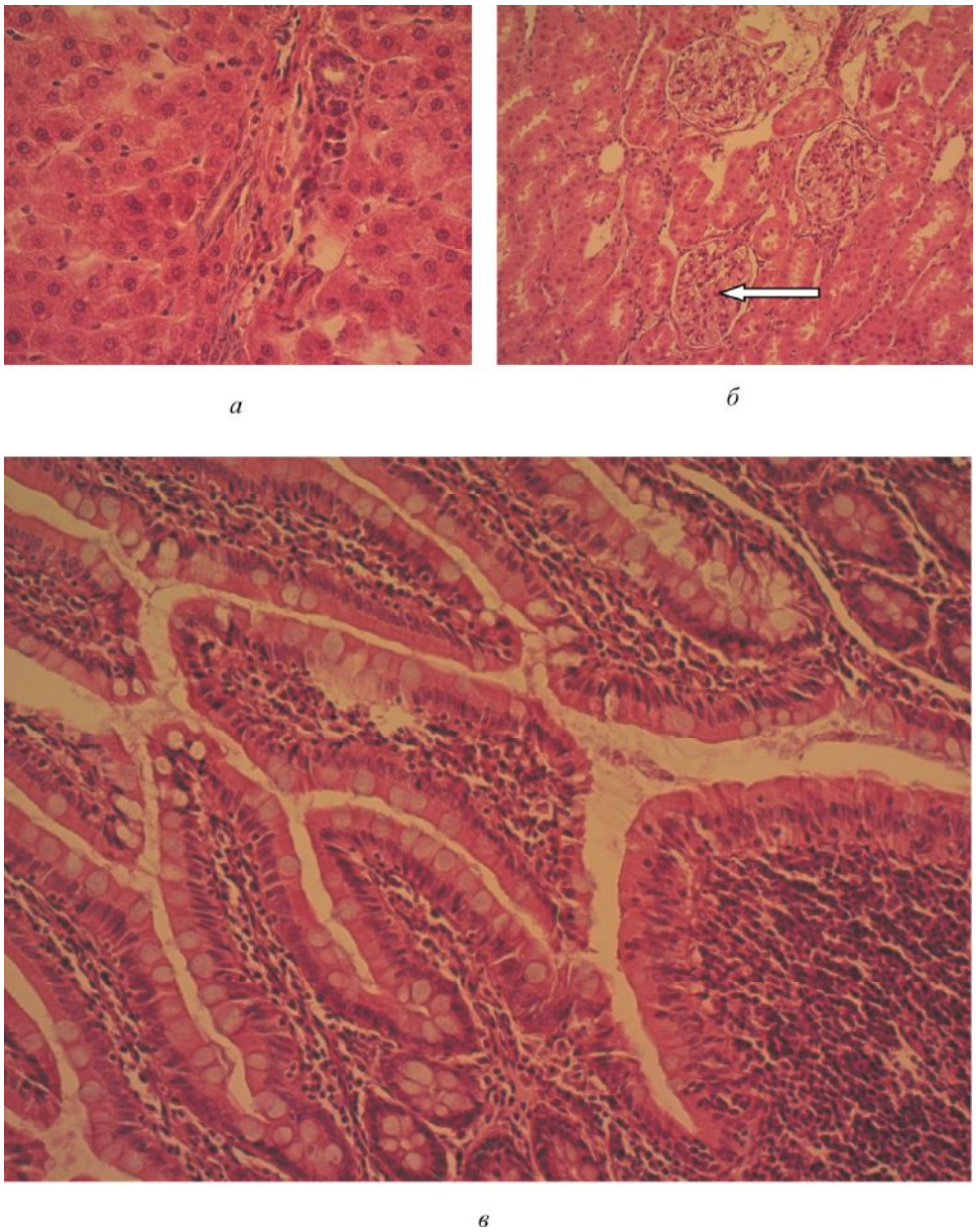


Figure 6. Representative microphotos of a rat from group 5 (silicon dioxide, 100 mg/kg b.w.) (painted with hematoxylin and eosin, magnification) ×200 (а, б); ×400 (в): а is liver; б is kidneys, arrow points at an artery; в is ileum

Lymphoid nodes formed mucous tunic evaginations between villi in a form of cupula covered with low epithelial cells with a great number of lymphocytes and macrophages. There were bunches of lymphocytes, macrophages, plasma cells, and numerous eosinophils in submucous layer.

Liver hepatocytes in animals from group 4 (silicon dioxide dose equal to 10 mg/kg of b.w.) had polygonal form, one or two nucleuses with fine-dispersed chromatin condensed at nuclear membrane and apparent nucleoluses. Hepatocytes cytoplasm was granular (Figure 5a).

Portal tracts contained evident infiltration from eosinophils, macrophages, lymphocytes, and plasma cells; some infiltrate cells penetrated into periportal sinusoids. We observed feebly apparent mesangial cells proliferation in glomerules (up to 6 in a lobule) without any increase in mesangial matrix volume (Figure 5b). There were no signs of proliferation of

capsule external leaf cells. A slight edema occurred in proper layer of ileum mucous tunic together with moderate lymph-macrophage infiltration with admixture consisting of numerous eosinophils and plasma cells. Paneth cells bunches were greatly visible in the base of intestinal epithelium crypts (Figure 5c). Solitary follicles were large and penetrated into submucous layer from proper layer. Peyer's plaques contained wide cell bunches of internodal lymphoid tissue. Crypts in Peyer's plaques view were not deep or they were even absent; villi were short and irregular-shaped. Lymphoid nodes formed mucous tunic evaginations between villi in a form of cupula covered with low prismatic epithelium with a great number of lymphocytes and macrophages. A moderate edema occurred in submucous layer; there was also diffuse lymph-macrophage infiltration with admixture consisting of numerous eosinophils. Muscular tunic in lymph follicles projection became substantially thinner.

Liver hepatocytes in animals from group 5 (silicon dioxide dose equal to 100 mg/kg of b.w.) had polygonal form, one or two nucleuses with fine-dispersed chromatin condensed at nuclear membrane and apparent nucleoluses. Hepatocytes cytoplasm was coarse-granular and eosinophilic (Figure 6a). Portal tract contained moderate infiltration from eosinophils, macrophages, and lymphocytes. Kupffer's cells were large and irregular-shaped; their prevalence was periportal. We observed feebly apparent mesangial cells proliferation in glomerules (up to 6 in a lobule) with a slight increase in mesangial matrix volume. There were no signs of proliferation of capsule external leaf cells (Figure 6b). Intraepithelial lymphoid tissue represented by solitary placed lymphocytes was greatly visible over a whole length of ileum mucous tunic epithelium. Villi had different width and form due to uneven edema and inflammatory infiltration consisting of macrophages, lymphocytes, and eosinophils (Figure 6c). Proper layer of mucous tunic contained a lot of macrophages, lymphocytes, plasma cells, and eosinophils.

Paneth cells bunches were well differentiated at the crypts bases. Solitary lymph nodes were large with big light prevailing reactive centers and wide cellular mantle zones; they penetrated into submucous layer from proper layer. Peyer's plaques contained up to 8 large secondary follicles and bunches of internodal lymphoid tissue and were located not only in proper layer but also in submucous layer. Crypts in Peyer's plaque projection were not deep or were not found at all; villi were short and irregular-shaped. Lymph nodes between villi evaginated mucous tunic into lumen in a form of a cupula covered with low epithelium (M-cells) with a big number of lymphocytes and macrophages. Follicles reactive centers contained centrocytes, centroblasts, immunoblasts, and a lot of macrophages. Mantle zones and internodal lymphoid tissue were represented by smaller lymphocytes with minute dark nucleuses, narrow cytoplasm ferrule, and macrophages. Submucous layer was represented by areolar fiber tissue with some lymphocytes bunches located in it, as well as with diffusely located eosinophils, macrophages, and plasma cells. Muscular tunic was substantially thinner in lymphatic follicles projection.

The obtained results reveal that there are changes in organs of animals from all the experimental groups in comparison with the control group. In case of liver, there is eosinophilic infiltration of portal tracts and granulosity of entherocytes cytoplasm; as for kidneys, we detected a relatively feebly apparent focal degeneration of nephron capsule external leaf. These changes don't have any evident dose-dependency in terms of introduced nanomaterial, and, as we may assume, they are quite similar to standard age-related changes which can occur in animals with age older than 4 months. Nevertheless, the trend which such changes have, in liver in particular, proves that there is a certain immune reaction enhancement caused by SiO_2 nanoparticles introduction.

Changes in ileum morphology are the most apparent; they include massive lymph-macrophage and eosinophilic infiltration of villi, submucous layer, and proper layer. The above-mentioned immune reaction enhance-

ment in ileum walls, which may result from SiO2 nanoparticles irritating effects, increases monotonically in the whole nanomaterial doses range. It doesn't allow us to determine the dose at which such changes authentically exceed the control group parameters. Still it is quite evident that when a maximum dose (100 mg/kg of body weight) is introduced, immune reaction enhancement in ileum wall becomes substantial.

Thus, amorphous SiO2 examined in this work is widely used in food industry as E551 food additive serving as anti-caking agent and a carrier. According to TR TS 029/012, E551 application is allowed in such food stuffs as spices (not more than 30 g/kg); products tightly wrapped in foil (30 g/kg); dry powder-like products including icing sugar (10 g/kg); cheese and its substitutes (10 g/kg); salt and its substitutes (10 g/kg); flavoring agents (50 g/kg). E551 is allowed to be used in children food products in a quantity up to 10 g/kg if this food additive is a part of a raw material which a finished product is made of. E551 application standard in such dry products as cereals made for children nutrition is 2 g/kg. E551 content is not regulated in biologically active additives to food and sugary confectionary (except chocolate) and is determined in accordance with a manufacturer's technical documentation. In most cases nano-sized structure of the applied silicon dioxide is not declared by food manufactures and it makes it next to impossible to define more or less precise volumes of this nanomaterial which are consumed with food.

As the experiment performed on mice [7] and dedicated to studying acute toxicity of nano-sized SiO2 showed, when the substance is once introduced via gastric tube in a dose equal to 10000 mg/kg, it doesn't lead to animals' death or intoxication. There were no morphologic changes in histological specimen of colon and jejunum.

On the other hand, according to research results obtained in experiments performed on a large number of model systems in vitro, SiO2 nanoparticles are cytotoxic when they contact with cells of various types. Thus, the work [15] describes how vitality of bronchial tubes epithelial cells (Beas-2B line) decreases due to the effects exerted by this nanomaterial; the material also causes peroxidation processes activation, shifts in proteom profile of intracellular kinase cascade enzymes. Increase in anti-inflammation cytokines production caused by amorphous SiO2 influence was detected in two lines of epithelial and endothelial cells in a lung [19]. Violation in nitrogen peroxide and peroxinitrite synthesis balance in vessels endothelium cells treated with these nanomaterials was detected in research [13] According to the results described in work [23], amorphous SiO2 nanoparticles in human cells of MCF-7 line were cytotoxic depending on a dose; they caused glutathione-S-transferase-1 hyperexpression in non-lethal concentrations. Thrombocytes aggregation effect was observed under SiO2 nanoparticles influence; the effect was mediated by influence exerted on balance between nitric oxide and peroxinitrite [14].

SiO2 nanoparticles caused damage to EAHY926 line cells, and here it should be noted that analog particles of sub-micron size (100-300nanometers) were not toxic [26]. Nano-sized SiO2 with particles diameter equal to 10 and 30, but not 80 nanometers suppressed differentiation into cardiac hystiocytes in stem cells culture of a mouse embryo [18]. Apoptosis and changes in p53, Bax and Bcl-2 expression caused by SiO2 nanoparticles with 21 nanometers size were detected in L-02 line hepatocytes [20]. Nanoparticles of such type led to release of multiple reactive oxygen forms, nitrogen oxide and TNF-□ in Kupffer's macrophages culture of rats' liver [12]. Research work [24] contains data on ability of the examined nanoparticles to stimulate autophagia processes in endothelial cells.

When amorphous SiO2 nanoparticles were introduced abdominally in very high doses (up to 2 g/kg of body weight), researchers detected shifts in peritoneal macrophages functions, higher production of IL-1b, TNF-a, NO, IL-1,6, TNF-agenes expression, nitrogen oxide synthase, and cyclooxigenase-2 [22]. Silica nanoparticles with diameter equal to 70 nanometers were hepatotoxic for rats when introduced intravenously in a dose equal to 30

mg/kg [21]. When nanomaterial was introduced into mice in the same manner in a dose 2-50 mg/kg of body weight, changes in CD3+, CD45+, CD4+ и CD8+ cells ratio in spleen were detected, and shifts in levels of crude immunoglobulins belonging to IgG and IgM classes occurred [28]. As per data taken from [29] SiO2 nanoparticles were able to enhance intranasal allergic sensitization of mice with an egg albumin model allergen. The same data on bronchial asthma model in rats caused by sensitization to an egg albumin were obtained in research work [17].

Authors in research work [27] examined subacute (during 84-day experiment) toxicity of two types of nanostructured SiO2 at oral introduction into rats in doses from 100 to 2500 mg/kg of body weight. An attempt to make quantitative assessment of SiO2 absorption and bioaccumulation in organs and tissues via mass-spectrometry led to ambiguous results due to high background level of silicon in organs of animals from control group. However, authentic increase in silicon content in liver and spleen of animals who received nanoparticles in the biggest doses was qualitatively fixed. Authors also detected dose-depending increase in fibrosis and expression of genes inducing this process in liver. Given all the above-mentioned parameters, authors assessed threshold dose (LOAEL) of SiO2 nanoparticles at subacute oral exposure as being equal to 2500 mg/kg of body weight, and maximum noneffective dose (NOAEL) was estimated to be equal to more than 100 mg/kg of body weight. The cited work has a drawback (and the authors themselves mention it) and it is related to very high doses of nanoparticles introduced into animals; such doses are incomparable to actual exposure with food which, according to authors' estimation, is equal to about 1.8 mg/kg of body weight a day. FSBSI Research Institute for Nutrition and FBSI Federal Scientific Center for Medical and Preventive Health Risk Management Technologies conducted joint research aimed at examining subacute oral toxicity which industrially manufactured nanostructured SiO2 of "Aerosil" type (with nanoparticles sized 20-60 nanometers) has for rats and mice; the experiment lasted for 92 days. As the results of research described in works [7–11] showed, animals which received SiO2 nanoparticles had apparent leucopenia, authentic decrease in T-helpers share and increase in cytotoxic lymphocytes share, immunoregulatory index (CD4/CD8) reduction, cytokines imbalance revealing itself in authentic multiple growth in TNF-alevel and apparent decrease in IL-10. Threshold dose of toxic effects exerted by SiO2nanoparticles at 92-day oral exposure for rats amounted to 100 mg/kg of body weight a day as per the examined parameters.

Morphologic data obtained in the current study confirm that if nano-sized SiO2 is introduced into animals' gastrointestinal tract under the same conditions, apparent immune reaction occurs in their ileum; this reaction extends onto lymphoid tissue associated with ileum wall and it becomes apparent in a form of massive lymph-macrophages and eosinophilic infiltration of villi without visible disorders in their epithelial layer structure. It can indirectly imply that there are no disorders in barrier function of intestinal epithelium and it coincides with the previously obtained results from work [8]. Given all the above-mentioned data on SiO2 nanoparticles research in systems in vitro and in vivo, we can assume that a trigger mechanism of such reaction is nanoparticles absorption by inter-epithelial macrophages and (or) macrophages contained in lymphatic follicles; it leads to further "respiratory blast" reaction, hyperproduction of reactive free-radical oxygen derivatives and production of anti-inflammatory cytokines and chemokines which cause involvement and activation of various immune cells. Such reaction can lead to systemic inflammation evolvement becoming apparent through above-mentioned shifts in T-cells immunity. At the same time, we need further examination (including ultrastructural level) if we want to get more information on details of local immune reaction evolvement in small intestine wall under exposure to SiO2 nanoparticles.

Conclusions. The examinations performed at light optical level detected evidence

of toxic effects exerted by SiO2 nanoparticles with specific surface area equal to 300 m2/g on animals' bodies at oral introduction in doses equal to 0.1-100 mg/kg of body weight during 92 days. First of all, these effects revealed themselves in immune and (or) inflammatory reaction evolvement in small intestine. The obtained results indicate there may be risks for human health when silicon dioxide (SiO2) with specific surface area equal to 300 m2/g and more is applied as a food additive in food industry.

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RISK ANALYSIS IN OCCUPATIONAL MEDICINE

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OCCUPATION AND PATHOLOGY OF THE CARDIOVASCULAR SYSTEM: FACTORS THAT MODIFY THE CAUSAL RELATIONS IN EPIDEMIOLOGICAL STUDIES

S.A. Maksimov, G.V. Artamonova

Research Institute for Complex Issues of Cardiovascular Diseases, 6 Sosnovyi Blvd., Kemerovo, 650000, Russian Federation

In scientific terms, the protection of workers' health is based on evidence of causal links between occupational factors and the onset of illness (or fatal case). The review considers the factors that modify the causal relations between occupational exposures and pathology of the cardiovascular system of workers in epidemiologic studies. Analysis of published data shows strong role of modifying impact of traditional risk factors, and healthy worker effect in shaping of the levels of cardiovascular disease in the working population. This modifying effect needs to be identified and eliminated at the moment of the analysis of the causal relations between occupational exposure and the development of diseases. Some of the most common methodological mistakes are presented on the example of the concrete case studies: ignoring the traditional risk factors for cardiovascular diseases, considering of correlations of occupational experience with the prevalence of diseases as causal, not as associative (due to age), lack of analysis of the possible occupational selection (artificial or spontaneous) of more healthy workers in poor working conditions. The main directions of methodological approaches of formation of the test samples, the results of analytical and statistical processing techniques eliminating the modifying effect were presented. The author's methodical methods that allow identifying and correction of the modifying effect of the healthy worker effect (healthy hire effect and healthy worker survivor effect) on the relative risk and etiologic fraction of disease in occupational groups on the basis of epidemiological data were highlighted in details. It is noted that a broader and more complete use of the modern developed methodological approaches to the formation of the test samples as well as to the results of analytical and statistical processing techniques, can significantly improve the adequacy and reliability of national epidemiological studies.

Key words: *cardiovascular disease, occupation, risk factors, healthy worker effect, epidemiological studies, methodical methods, evidence-based medicine.*

International healthcare system since 1990-s is actively introducing evidence-based approaches, with decisions on using preventive, diagnostic and therapeutic measures taken based on the available evidence of their effectiveness and safety on the background of search, comparison, generalization and distribution for the benefit of patients [31]. And occupational medicine, the evidence principle thereof is to cover all the aspects in scientific and clinical process: prevention, diagnosis, treatment and rehabilitation, is not an exception [1].

In scientific terms, protection of employed population health is based on the evidence of causal links between occupational factors and onset of illness (or fatality). After all, in order to prevent occupational factors

Sergey A. Maksimov – PhD in Medical Science, associate professor; Leading Researcher of the Laboratory of Epidemiology of cardiovascular diseases (e-mail: m1979sa@yandex.ru; tel.: +7 (384)2 64-42-40).

Galina V. Artamonova – Doctor of Medical Science, Professor, Deputy Director for Scientific Affairs, Head of the Department of optimization of medical technologies in cardiovascular diseases (e-mail: artamonova@kemcardio.ru; tel.: +7 (384) 264-45-73).

impact, you must first prove that, namely, the occupational exposure is the direct cause (or one of the main reasons) for the disease development. At the same time, establishing cause-and-effect relationships in occupational medicine is accompanied with certain difficulties. The standard clinical studies, a double blind randomized controlled parallel groups study in a large number of patients, cannot be applied in many cases in occupational medicine [1]. The principles of the evidence-based medicine therefore are necessary to be supported by the available means in the course of cohort and intervention studies.

For the diseases of multifactorial etiology, eliminating the modifying effect of the traditional (non-occupational) risk factors is a prerequisite for the evidence of cause-and-effect relationships. Considering professional occupation as a specific group of people living under the effects of certain production factors, the cause-and-effect relationship analysis should take into account, inter alia, dynamics of trends in employees' health. As part of the present review, this applies primarily to eventual inconsistency of the original (that is, at start of the employment) health status, as well as to differences in the health status of the retiring employees in test and reference groups. The first one is designated in scientific literature as healthy worker effect (HWE), the second one – as healthy worker survivor effect (HWE who continues labor activity). Both phenomena are generalized with the term "Healthy Worker Effect" (HWE).

Schematically, the prevalence of the disease under study in the occupational group is the effect of the working environment hygienic parameters, traditional risk factors and HWE [12] on health status:

1. Working environment has a direct impact on the risk of disease development (i.e., the same cause-and-effect relationship that needs to be found);

2. Working environment, under otherwise equal conditions, determine the prevalence of traditional risk factors for the disease;

3. Working environment determines workers functional level and physical health required for successful labor activity, resulting in HWE evidence;

4. Evidence of HWE by differences in the occupational groups' health status determines the prevalence of a disease and the traditional risk factors thereof;

5. Prevalence of traditional factors has a direct effect on the risk of developing the disease.

Casual relationship of the occupational effect on health is characterized by the first coherence. The last two – are the modifying effect, distorting this causal relationship and requiring to be excluded, that ensures compliance with the principles of evidence-based medicine at occupational risks assessment. A correct study management, adequate choice of groups – test and reference, using the updated means of mathematical statistics in epidemiological studies allows for identification and "neutralization" of the main factors that can modify causal relationship between the occupational exposure and the disease development.

The purpose of the present review is to consider the factors that modify cause-and-effect relationships between occupational exposures and pathology of the cardiovascular system of the employed people in epidemiological studies.

Traditional factors of cardiovascular risk.

To date, it is clear that cardiovascular disease (CVD) prevalence depends mainly on preventable causes, primarily associated with lifestyle, preventive effect thereof may slow down cardiovascular disease progression, both before and after onset of clinical symptoms. First of all, it refers to 7 risk factors, being key contributors to premature cardiovascular mortality: arterial hypertension (35.5%), hypercholesterolemia (23%), smoking (17.1%), insufficient intake of fruit and vegetables (12 9%), overweight (12.5%), excessive alcohol consumption (11.9%), hypodynamia (9%) [17]. INTERHEART study demonstrated that 9 risk factors (the above-mentioned 7 plus diabetes and stress) explain 90% of the population-attributable risk of myocardial infarction [28].

However, consideration of the modifying effect of the traditional CVD risk factors should be started with an age, as one of the most important biological factors of cardiovascular risk. It should be borne in mind that aging is accompanied with an increasing prevalence of a number of critical risk factors: hypertension, diabetes, overweight, hypercholesterolemia, decreased physical activity [12].

The logical is the dependence of the employees' age structure on the occupational characteristics. The process of natural aging is accompanied with a decrease in adaptive capacity, morphological and functional changes in major body's systems, that leads to cumulating decrease in general and occupational ability to work, mental and physical performance [26]. It causes limitations to perform certain occupational duties, or a significant increase in physiological cost of the work performed, and accordingly to disruption of adaptabilities and development of pathological conditions [29]. As a result, in the professions related to the need for rapid response, high coordination of movements, performing higher physical activities, the proportion of people in older age groups is lower. [12] At the same time, high employment rate of older people is recorded in the professions more appropriate to their reduced functionality [21].

In this connection, comparing occupational groups of different age structure will necessarily lead to "bias" in the obtained results towards increasing prevalence of cardiovascular disease, and, in addition, towards a number of risk factors in the "older" occupational group. For example, it is revealed that shift in hypertension prevalence is accompanied with unidirectional change in the age structure and obesity prevalence in the occupational groups [14]. In particular, in occupations with a high incidence of hypertension, the employees' average age reached 43.0 ± 2.1 years old, while the share of persons older than 50 years: 28%, the share of people with obese: 20%. Occupations with low incidence of hypertension were characterized by the significantly lower average age: 39.6 ± 1.2 years, proportion of individuals older than 50 years: 14%, prevalence of obesity: 15%.

Therefore, along with age, other risk factors require consideration and, if possible, elimination of the modifying effect on causal relationships between the exposure to occupational factors and CVD. Moreover, a significant number of studies have shown the dependence of different risk factors prevalence on the occupational features: obesity [39], hypercholesterolemia [38], smoking [36], alcohol abuse [23] and others.

Meanwhile, the lack of analysis in the modifying effect of traditional risk factors (especially the age) on associations between the exposure to occupational factors and CVD in Russian studies is very common [3-6, 16].

For example, in the study [10], based on the obtained results, the authors confirm the relationship between occupation of driver with the risk factors prevalence and coronary heart disease. The data do show an increased prevalence of risk factors and coronary heart disease in drivers. However, it is not clear, if the occupational factors directly potentiate development of coronary artery disease, or, perhaps, it is the working environment that causes increase in the prevalence of risk factors, and the latter have influence on CVD prevalence respectively? The answer to this question determines possibility of considering coronary artery disease, as an occupational or occupational-mediated disease, that ultimately reflects the need, as well as the direction and scope of preventing the adverse effects of working environment.

In the study [22], one of the evidence of the occupational factors effect on the development of cardiophyshoneurosis in gas-processing industry was a higher actual prevalence of the disease among women having "... a smaller range of adaptive capabilities to adverse environmental conditions ..." However, the authors did not pay attention to the fact that the disease in question is also recorded more frequently in women population in general, which is a feature of the gender prevalence of neuro-dystonia.

The authors in the given study did not get the link between a higher disease prevalence and period of employment that they explained by stable hygienic situation at the enterprise. Despite it is quite possible, after all, first it is necessary to proceed from the fact that cardiopsychoneurosis is often diagnosed in young and middle age, that is, in workers with short period of employment. Thereby, the consistencies, the authors got, do not reflect occupational dependence of the diseases, but merely the associative links (age – period of employment, age – disease, period of employment – disease), which are not always cause-and-effect.

The CVD dependence on occupational factors is often confirmed by the existing correlations between disease prevalence and employment period. At the same time, it may often be a serious methodological error [2-6, 16, 22]. In most cases, period of employment is closely (a direct strong correlation) associated with employees' age. And when you consider that probability of CVD development in major cases and risk factors is also closely linked to age (also a direct strong correlation), then one-factor correlations of an employment period with CVD and risk factors are typically not cause-and-effect, but rather associative, i.e., mediated by age.

Eliminating the modifying effect of CVD traditional risk factors is optimally achieved by forming such occupational groups for study, in which the differences by the given risk factors are minimized. In case it's impossible, and it happens often enough, the modifying effect of traditional risk factors is excluded at the stage of data analysis using statistical methods of processing.

For example, in studying 13 occupational groups of men, direct standardization [13] was used for this purpose. Eliminating the effect of age and obesity led to changes in the initial values of occupational risks of hypertension by an average of 10%, and the level of statistical significance of disease risks in four occupational groups changed. It was found that high prevalence of hypertension among managers, maintenance and technical personnel and, on the other hand, low disease prevalence among the subsurface equipment operators and heavy unskilled labor staff is not connected with the working conditions, but with high/low share of persons with obesity and of aging workers in these occupational groups.

In foreign studies, a common methodological technique to eliminate the modifying factors impact is the use of multivariate linear or logistic regression analysis. At the first stage a single-factor relationship of a disease with occupational factor is considered, at the second: risk factors as independent predictors are added to the regression analysis. In this case, if the relationship between disease prevalence and occupational factors remains statistically significant, it is only in this case, causal link is ascertained. A similar sequence of actions is at using partial correlations.

Healthy worker effect. Currently HWE is regarded as an organized and / or disorganized occupational selection of healthier workers in poor working conditions, which leads to better health parameters, compared with those employed with more favorable labor conditions or with the population in general. As a result, actual increase in morbidity/mortality as occupational factors effect may be wholly or partially "masked" [11, 34].

HWE could be a consequence of two reasons. First, individuals with poor health are excluded from professional activity, since pathological or functional abnormalities can be theoretically or actually an obstacle to adequate execution of professional duties. Secondly, executing professional duties by healthy person or on the back of existing pathological or functional abnormalities leads to (or can cause) health deterioration.

On the other hand, health deterioration in occupational cohort, as compared with the reference group, is always treated as a result of occupational exposure. Such studies do not consider the eventual HWE-reverse phenomenon. Meanwhile, if individuals with impaired health are excluded from some professional cohorts, they will add another occupational

cohort that increases the diseases prevalence therein [12].

The HWE phenomenon conditionally allocates two components: healthy hire effect (HHE, Eng: healthy hire effect) and healthy worker effect to continue labor activity (HWSE, Eng: healthy worker survivor effect) [11].

HHE characterizes HWE in a starting period of employees' professional activity, due to the fact that healthier individuals apply to work in adverse working conditions or to an employment at all, compared to individuals with poorer health status or with reduced functionality. HHE identification is not difficult. Hypothetically, among young adults, job seekers, a health should not be fundamentally different from the general population, and the working conditions effect on health should occur only after a certain period of exposure (time of employment). Therefore, the best indicators of health status among young adults with a minimum length of employment, compared with the general population or other professional cohort, indicates HHE.

HWSE refers to the ongoing process of occupational selection and is characterized by the fact that individuals who continue working are healthier than those who leave professional activity. For example, it is shown that retiring workers in agriculture have worse health in terms of CVD compared with those who continue labor activity [20].

HWE at CVD is clearly seen at an early working age [30]. The Croatian study of hypertension prevalence on the example of six occupational groups is indicative in this respect [37]. The study results did not confirm the existence of positive relationship between potentially hazardous working conditions in professional occupations considered s and development of the disease. The minimum prevalence of hypertension was observed in the workers of transportation, characterized by heavy physical labor, the maximum prevalence of the disease – in the warehouse staff. However, the authors noted that the occupational cohort of warehouse workers is made up largely from the transport workers, being transferred, due to age, illness or reduced performance, to a lighter work.

Another study [15] showed lower, compared to the all-Russia data and the other occupational groups, prevalence of hypertension in underground miners (including the youngest), exposed to a number of unfavorable factors of production. In this case, HWE should be seen as a consequence of the legislated selection of healthy individuals for employment in underground conditions (Order of the Health Ministry of Russia ddt. April 12, 2011 No. 302n "On approval of lists of harmful and (or) hazardous production factors and works, subject to compulsory preliminary and periodic medical examinations (surveys) and the Order of mandatory preliminary and periodic medical examinations (surveys) of individuals employed in heavy work or work in harmful and (or) dangerous working conditions").

Unfortunately, similar studies considering the causes of cardiovascular disease prevalence in occupational groups are sporadic. The vast majority of studies merely state the fact of an increased or decreased prevalence of the disease, which is interpreted as presence/absence of CVD occupational dependence [18]. Several studies also testify certain illogicality in reducing CVD prevalence in occupational groups, characterized by unfavorable working conditions and increase in the prevalence of cardiovascular disease in relatively favorable occupations [24, 27].

The studies [2, 8-9, 19] observe an increase in the prevalence of cardiovascular disease in occupational groups of vehicles drivers, which is associated with psycho-emotional effect of work, with a decrease in motor activity that represents both independent and indirect (through an increase in body mass index) risk factor. The eventual effect of these factors causes no doubt, but that does not reduce probable "accumulation" of persons with cardiovascular disease in a cohort of professional drivers. Three of these studies [2, 8-9] involved age-specific analysis of the cardiovascular disease prevalence that showed, as a rule, high prevalence of the disease in all age groups, including the youngest. As noted

above, hypothetically young drivers health status should not be fundamentally different from the general population, and working conditions impact and reduced motor activity against health status should become evident only after a certain period of exposure (time). Therefore, high prevalence of CVD among young drivers indicates most likely an initially worse state of health.

It is indicative in the given aspect a comparative analysis of anthropometric, biochemical parameters and pressure levels of young (21-24 years old) London conductors and drivers [33]. The higher weight, fat content, lipid concentrations and the elevated blood pressure levels are observed in drivers already in young age. According to the authors, it characterizes not the occupational exposure, but the profiles of occupational selection.

Nowadays, in order to reduce /eliminate HWE, the approaches developed at the end of the XX century are used. Much attention in reducing the influence of HWE on causal relationship between occupational exposure and health parameters is given to careful planning and selection of reference groups. At the same time, it is recommended not to use general population as reference, but workers of the other occupations with the absence of the risk factors under study or workers of the same occupation, differing only in the degree of exposure to these risk factors.

One of the most effective control areas in HWE is recognized the occupational cohort analysis of health parameters, taking into account those who left the given cohort. At the same time, workers, who leave their professional occupation, exhibit increased mortality or morbidity, which is one of the evidences of HWSE.

Since the late 1970s, in order to reduce HWE, the standard analytical methods of data processing are in use: relative and standardized risks [25, 35], stratification analysis, taking into account age and gender as modifying factors [35], employment status [25], logging an exposure [25, 34-35], structural modeling [32]. However, it is clear to date, that a common method allowing for HWE elimination have failed to get developed, so the current trend is a comprehensive approach to assessing HWE existence and possibilities to exclude it in each particular study [11].

We have developed methodological approaches that allow by epidemiological data to identify and correct HWE modifying effect on a relative risk and etiologic share of the disease in occupational groups. In this case, identification and correction of two main influencing components in HWE (HHE and HWSE) are different. Epidemiological study of transversal design identifies and eliminates the potential modifying effect of HWE only. Identification and elimination of HWSE can only be possible, if data on health status of people who left profession are available for a certain period of time. In addition, the similar data on the reference group are necessary.

To identify HHE, we did age-specific and employment time-related analysis of health deteriorations prevalence in the workers. In this case, it is assumed that the differences in health deteriorations prevalence in the minimum age/employment time groups of the compared professional employment time-related cohorts would indicate the presence of HHE.

When you select grouping by age or length of employment period, it should be borne in mind that both the one and the other have their own advantages and disadvantages. One of the basic axioms of HHE identification method developed is the assumption that working conditions impact on health should appear only after a certain period of exposure (time). However, the length of the worker's professional employment period is difficult to control due to individual features of eventual occupational route. For example, a man may be employed directly by the profession considered, since reached his working age, can go into it later in life from a similar profession or from a completely different profession. Finally, a man can start his labor activity not since his working age is achieved, but after a while.

In contrast to the employment time-period, an employee's age is an easily controlled indication, which is, moreover, strongly

correlated with the employment time-period. Usually, grouping by age in general provides adequate grouping of workers by professional occupation period, that is, a young-age group includes mostly employees with a minimum occupation period. Furthermore, when all the population is used as reference group, it is not always possible to consider professional employment period, in many cases such data are simply absent.

To reveal HHE, it's greatly important to identify certain age/employment period the diseases developed wherein are recognized as not associated with occupational exposure. Due to the fact that in many cases time-period relationship of the disease in question with occupational factors effect is not established, a minimum age/employment period is accepted as: age under 25 years old, under 30 years old, or employment period of up to 5 years, up to 10 years.

It should be noted that the proposed algorithm for HHE identification is applicable not for all health disorders. Several CVD cases develop mainly in older age, such as coronary heart disease. Therefore, the disease prevalence in the analysis of minimum age or employment-period groups will show nothing. For example, under 30 years old, CHD is recorded in individual cases, in view of this, lack of differences in the disease prevalence in the given age group prevents from stating HHE absence. In this case it's useful to analyze the indices of predisposition to cardiovascular disease, in particular, the risk factors.

HHE on the incidence of cardiovascular disease is excluded by correcting the benchmark data for the disease prevalence in a minimum age or employment period group. A correction algorithm includes a series of successive analytical transforming the benchmark data of the test group by standardization type. The correction is based on the assumption that an incidence of HHE should manifest itself equally in all age groups. That is, a relative risk of CVD in young workers of the test and reference groups should not change with increasing age, and any deviations will not be HHE-associated. According to the corrected absolute values of the number of patients, we can calculate the disease prevalence, as well as the relative risk value without HHE.

As noted above, identification and elimination of HWSE is possible provided the available data on the health status of persons retired from the test and reference occupations for a certain period of time. Significant differences in the proportion of patients among the resigning in these groups may indicate HWSE. It should be noted that, when identifying HWSE, data on the health status of retiring workers should be taken into account for the same period of time for the test and reference groups. What time period will be taken into account: 1 year, 2 years, 3 years, 5 years does not matter. It is only necessary to bear in mind that this time period will characterize HWSE calculated.

At the first stage we calculate the proportion of the retired sick workers from the total number of the test and reference groups, and the difference between them. The differences intensity characterizes the intensity of HWSE. The identified HWSE incidence towards CVD prevalence and risk is eliminated by standardized correcting the number of workers with pathology in the test group for the difference of the retired with CVD in the test and reference groups.

Approbation of our methodological approaches on the example of hypertension in 13 occupational groups of men gave positive results [7]. In the course of successive correcting and eliminating HHE and HWSE incidence, in a number of occupational groups we obtained values of risks significantly different from the benchmarks. The variations in hypertension risk values at correction for HHE ranged from 6% to 76% (37% in average), for HWSE – from 0% to 11% (5% in average).

Conclusion. Thus, the published data show stronger role of the modifying impact of traditional risk factors and HWE in forming the levels of CVD in the employed population. This modifying effect is necessary to be identified and excluded when analyzing causal relationships between occupational exposure and CVD development. A wider and more exten-

sive use of the actually developed methodological approaches to the formation of test samplings, of analytical and statistical results processing techniques allow for significant increase in adequacy and reliability of the national epidemiological studies.

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ADAPTATION OF THE MIGRANT WORKER'S BODY TO THE OCCUPATIONAL RISK FACTORS FROM THE POSITION OF FUNCTIONAL SYSTEM OF P.K. ANOKHIN

M. Khodzhiev, L.V. Prokopenko, N.P. Golovkova, G.I.Tikhonova, M.A. Fesenko

Research Institute of Occupational Health, 31 Budennov Prospekt, Moscow, 105275, Russian Federation

The adverse factors of labor process of migrants were studied as the factors of risk of formation of unsatisfactory adaptation and damage to health. The results of the study of adaptation of migrants to the labor process from the standpoint of the theory of functional systems were presented. The first subsystem of physical activities and neuro-emotional tension of labor determines the formation of certain stages of the adaptation process in terms of heart rate variability (the second subsystem). The result of migrant workers' sympathetic chain of regulation's activity level shows that the adaptive stress syndrome on the physiological indicators is expressed in a change of heart rate variability: different levels of stress index of SI associated with high physical (muscle), neuro-emotional stresses; marked increase in the power of spectrum of very low-frequency component (VLF), while the increase in heart rate. The features of the functional state of the body and the degree of adaptation in terms of activity of regulatory systems – PARS (optimal 1.19 ± 0.28; allowable stress 40.5 ± 0.62; overvoltage 6.21 ± 0.82 points) were determined. On the basis of the production studies of migrant workers, the approaches to quantitative evaluation to the degree of adaptation of workers to the labor process associated with the combined effects of physical, neural and emotional labor intensity on the human body were science-based and developed. The degree of stress adaptation process corresponds to the stage of self-control (optimum stress) activation (allowable stress), the mobilization of the 1st, 2nd, 3-th degree (degrees of over-stress of 1,2,3 degrees). Unfavorable stage of mobilization of 2–3 degrees of migrant workers was determined (an increase in the stress index S1, PARS indicator, the relative power of VLF range, a reduction in the SDNN). Events of medical and social support represent the third sub-system in the general system theory.

Key words: *migrant workers, adaptation, system approach, muscular load, neural and emotional kind of work, healthy lifestyle.*

Relevance. Examining adaptive responses which occur in working activities is in most cases re-lated to a necessity to carry out quantitative estimation of physiological costs for works including physical (muscle) and neuro-emotional loads [1]. And as labor physiologists in the previous cen-tury were mostly dealing with issues related to fatigue and over-fatigue, nowadays such prob-lems as stress and overstress become the focus of attention; and issue of a man's adaptation to various environmental conditions is undoubtedly the most important one.

This adaptation issue has occurred due to formation of such social phenomenon as labor migration on the whole territory of the former USSR. Nowadays, labor migration of young people from Central Asia countries is

Makhmadamin Khodzhaev – PhD of Medical Science, senior researcher of laboratory of labor physiology and preventive ergonomics (e-mail: amin.dok@mail.ru; tel.: +7 (968) 585-12-95).

Lyudmila V. Prokopenko – Doctor of Medical Science, professor, deputy Director for Research (e-mail: prokopenko@niimt.ru; tel.: +7 (495) 365-46-03).

Nina P. Golovkova – Doctor of Medical Science, Head of laboratory of complex problems Industry of Occupational Medicine (e-mail: niimt@niimt.ru; tel.: +7 (495) 366-44-47).

Galina I. Tikhonova – Doctor of Medical Science, Head. Laboratory of social and health studies (e-mail: gtikhonova@ya.ru; tel.: +7 (495) 366-05-66).

Marina A. Fesenko – Doctor of Medical Science, Head of Laboratory for the prevention of violations of reproductive health of workers (e-mail: reprlab@mail.ru; tel.: +7 (495) 365-29-81).

widely spread; they come to Russia in order to find work with decent earnings. But migrants' working activity entails impacts exerted on a human body by a whole set of social-psychological and climate and geographic conditions as well as factors caused by increased labor hardness and neuro-emotional intensity of labor.

Adverse factors of labor hardness are studied by a number of authors as risk factors caus-ing occupational diseases of musculoskeletal system and peripheral nervous system. Probability of occupational disease frequency amounted to not more than 6% at regional and total loads at optimal 1st category of labor hardness. If labor conditions belonged to the 2nd category (accept-able stress) pathological disorders frequency didn't exceed 17%. In case of adverse (hard) 3rd category labor occupational diseases occurred in 17.1 - 28.0% cases; if labor condition category was 3.2, 28.1 - 37.0% cases; if labor condition category is 3.3 occupational diseases may occur in more than 37% cases [8].

Basing on the results obtained through production and physiological-clinical research we considered the detected values of neuro-emotional labor intensity to be risk factors causing pro-duction-induced pathology evolvement. Clinical research results prove that the higher labor in-tensity category is, the bigger is the share of people with a detected pathology (primary hyper-tension, ischemic heart disease, and neurotic disorders). As per data taken from scientific litera-ture men tend to have greater % of cardiovascular system pathology, and women, nervous system pathology [7, 8].

In most cases, unskilled workers employed at construction sites, road network repairing, and in social sphere suffer from significant stress of adaptation mechanisms even up to depletion of body physiological reserves. Morbidity structure of labor migrants from Tajikistan based on the length of their stay in Russia proves it. Dealing with physical and neuro-emotional labor, mi-grants are exposed to various climate and geographic, social, and neuro-psychological factors which cause diseases evolvement in them.

According to A.P. Berseneva [5] a new approach to health state assessment has been de-veloped: it is based on a degree of a man' s organism adaptation to working conditions and envi-ronment. Here mostly parameters describing regulatory system state and their functional reserve are used as estimation criteria. Degree of regulatory systems stress determines "costs" of a body adaptation to environmental conditions.

Groups of people with different adaptation levels are detected; the first group with satis-factory adaptation to environmental conditions; the second group, with stress of adaptation me-chanisms; the third group, with unsatisfactory adaptation; the fourth group, with adaptation me-chanisms failure. Mass prognostic research technique is mostly based on data concerning cardi-ovascular system state which is considered to be an indicator of a body adaptive responses; this technique is profoundly described in articles and monographs. We used the above-mentioned approach to assessing degree of labor migrants adaptation to factor of labor physical hardness and labor neuro-emotional intensity, as well as social and psychological conditions of environment, and expanded the set of applied research techniques. We assessed neuromuscular system state, applied correlation analysis to reveal correlation between physiological parameters and working process factors and regression analysis to give quantitative grounds for adaptation process stages.

The research goal was to give scientific grounds for physiological and clinical peculiarities which are characteristic for adaptation of migrants from Tajikistan to production, social and psychological and environmental (climatic) conditions of Moscow region; to work our measurements aimed at medical and social support for labor migrants.

If we consider how a man adapts to various production factors and environmental conditions within the framework of system approach developed by P.K. Anokhin [2], we should pay special attention to functional system formation.

It is system approach that can "help to get an insight into logical correlations between separate facts, and only this approach helps to design new research more successfully and on a higher level" [4]. A search for a system-forming factor is obligatory for system approach. As A.V. Kapustina et al state (2016), it is physical efficiency concept that is of critical importance for system formation in labor physiology as it is related to both labor hardness and neuro-emotional labor intensity as well as to functional state and level of body adaptive responses.

Nowadays, physical efficiency is viewed as amount of body functional possibilities which characterizes a man's capacity to complete maximum amount of work within a specified period of time under intense or long-term stress. Previously, physical efficiency was determined as per technical and economic indices of work, i.e. labor productivity; however, this approach turned out to be insufficient. If we consider labor hardness and labor intensity to be the first subsystem, it becomes evident that impact exerted by adverse factors of increased labor hard-ness and neuro-emotional labor intensity can lead to decrease in physical efficiency as well as changes in functional state of all body systems. Body physiological state and adaptation process level (stage) can be taken as another subsystem in basic system theory. Recovery of resources spent in labor process makes it necessary to correct functional state applying primary prevention activities (procedures to make oneself fit, basic physical training etc.).

Secondary prevention activities (medical examination, regular check-ups) is aimed at preserving high physical efficiency level, preventing occupational and production-induced pathology evolvement. Giving grounds for prevention activities aimed at increasing physical efficiency and optimal development of adaptive responses can be determined as the third subsystem.

Considering physical efficiency of a man as a functional system, V.V. Matyukhin [9] outlines two interrelated subsystems, functional stress and recovery processes. However, it seems justified to outline three subsystems on the contemporary stage of labor physiology de-velopment; they are migrants labor activity in terms of physical (muscle) labor loads parameters and neuro-emotional labor intensity loads, functional state as a certain level of adaptation process formation (which often has such stages as self-regulation, activation and mobilization), physiological functions recovery with the use of labor optimization activities and health-improving activities.

Data and methods. Given all the above-mentioned, we should consider each subsystem in greater details and describe basic features of a functional system. Physiological research included job analysis as per Guide P2.2.2006-05 [10]; we assessed body functional state as per conventional techniques, such as dynamometry, heart rate definition, systolic pressure measuring, diastolic pressure measuring, physiological changes index (PCI) for circulatory system, heart rate variability, and circulation regulation type (hypo-, hyper- or eukinetic). Psychological testing included defining personal and situational anxiety (Spielberg test) and neurosis level (Eysench technique).

Comparative analysis of adaptation process in labor migrants depending on volumes of physical and neuro-emotional loads

Basing on examination of professional activity type, we formed professional groups of labor migrants depending on degree of their hazard as per labor hardness and intensity parameters. As the obtained data were systematized, we managed to outline several categories of labor activities. Each category of professional activity comprised representatives from occupations with 2 and 3 hazard class and 1, 2 and 3 hazard category in accordance with P 2.2.2006-05. Here students of the first-third year attending Tajik State Medical University and Moscow Mining In-stitute were included into a group with the 2nd (acceptable) class as per labor hardness parame-ters. Workers employed at fruit and vegetable market as well as students sportsmen going in for bullet shooting were estimated as having 3rd class with the 1st labor conditions category. The 3rd class with the 2nd category included builders-erectors, road network repairmen, female migrants employed in social sphere, and students sportsmen playing volleyball, futsal, as well as doing taekwondo. The 3rd class

with the 3rd category comprised builders-steelmen, subway builders, fruit and vegetable warehouse workers etc. As we analyzed professional groups distribution as per generalized parameter of labor intensity, we came to a conclusion that the 3rd class with 2-3- category prevailed (72.7%), and the 3rd class with the 1st category had 27.3%. The high level of neuro-emotional labor intensity indicates that emotional stress may evolve and it can cause deadaptation and failure of body compensatory mechanisms.

Correlation analysis of labor hardness factors and neuro-emotional labor intensity factors with physiological parameters of neuromuscular and cardiovascular systems enabled distributing them as per rank places. Labor hardness occupied the central place in this system while other factors were distributed as per their rank in the following order: working posture (is authentically related to physiological parameters in 93,3% cases, $p \leq 0.05$), static load (80.0%), labor intensity (73.3%), emotional load (66.7%). Such labor hardness parameters as weight elevated and moved manually and body bendings, followed.

Impact exerted by adverse factors of labor hardness and apparent neuro-emotional labor intensity induces changes in functional state of all body systems, forms peculiarities of adaptive responses, which can be considered the second subsystem in basic system theory. Today there isn't any quantitative definition of stages in sequential transition of adaptive responses from self -regulation to mobilization with various evidence degree; we haven't also found any attempts to detect correlations between stages and physical hardness degree and emotional intensity of labor.

High labor input which is required to detect adaptation processes stress under joint impact exerted by labor hardness factors and labor intensity factors in production conditions made it ne-cessary to give methodical grounds for assessment of labor migrants' adaptation at physical and neuro-emotional labor.

Quantitative assessment technique applied to define body adaptation processes stress as per research results envisages preliminary definition of labor loads nature. First, we determined labor conditions class as per such parameters as physical dynamic load, cargo weight, stereotyped working movements, static load, working posture, body bending, movements in space, for these parameters make up the total estimation of labor process hardness. Second, we assessed labor conditions class as per values of intellectual, sensory, emotional, and monotonous load and working regime which make up labor intensity estimation as per techniques stated in Guide P 2.2.2006-05 [10].

After these two steps were completed we defined value of each parameter in terms of labor conditions class. Conditional coding in % and points for labor conditions classes revealed that optimal 1st labor conditions class had 6.7 points; acceptable 2nd class, 13.3 points; hazard 3rd class with the 1st category, 20.0 points, hazard 3rd class with the 2nd category, 26.7 points, hazard 3rd class with the 3rd category, 33.3 points. In case of physical labor total score value of each load type was determined as per parameter having the biggest class. In case of neuro-emotional labor, assessment of each load type was made in a different way, namely, total score value of each load type was calculated as per formula of score as per patent No. 2546089 issued on February 27, 2015.

The performed analysis of psychophysiologic data taken on labor migrants during a working shift revealed that functional state formation was determined as per level of labor hardness and labor intensity. Builders-steelmen with 3.3 labor hardness class had 25.6% lower dynamometric parameters of body supporting muscles endurance and 36% lower maximum muscular performance (MMP) in comparison with baseline; complaints on pain in loin area occurred in 65.3% cases by the end of the work shift; in thoracic girdle, in 62.3% cases; in cervical spine, in 58.4% cases.

Changes in neuromuscular system of builders-erectors having 3.2 labor hardness class in shift dynamics were less apparent. Doing work related to neuro-emotional stress causes more apparent changes in cardiovascular parameters. Research results show that heart rate, systolic pressure, and diastolic

pressure measuring as per average shift levels gave more information for workers involved in neuro-emotional work than changes in parameters determined by the end of a work shift; such average shift levels measuring can be used to determine adaptive responses stress. We assessed functional state of cardiovascular system in workers from the examined pro-fessional groups basing also on the integral parameter, namely, physiological changes index (PSI) for circulatory system. This index reveals potential capability of a body to adapt to various production loads, i.e. to actual production activity.

The results of examination performed on labor migrants, students and students sportsmen revealed that students who experienced physical loads corresponding to the 2nd acceptable class of labor hardness had low average monthly values of PSI which was the evidence of sufficient functional capabilities of physiological systems and satisfactory adaptation of the examined stu-dents' bodies. Average shift values of PSI detected in builders with labor conditioned assessed as per labor hardness and labor intensity and considered to be the hazard 3rd class with the 2nd and 3rd category indicated that functional capabilities were reduced and a body adaptation to labor load was unsatisfactory.

As degree of adaptation stress grew from self-regulation stage to activation and mobiliza-tion it became apparent in growing share of labor migrants with high level of personal (42.8%) and situational (45.6%) anxiety and students with increased neurosis level (42.9%). Research dedicated to several personality traits seemingly points at probable neurotic disorders evolvement in people with great neuro-emotional labor loads. The obtained results gave us a possibility to justify quantitative assessment of body adaptive responses stress which included calculating reduction in neuromuscular system parameters (% of a shift from the baseline) and deviations in average shift levels in cardiovascular system parameters, including heart rate variability, from normative and due values (in %).

We used regression analysis to analyze data on changes in adaptation processes collected on a lot of working people by the end of a working shift as per neuromuscular and cardiovascu-lar system; it allowed us to create a formula to define a level of a body adaptive responses stress. Adaptation process stage is determined as per level of body adaptation stress under influence exerted by labor hardness factors and labor intensity factors at physical and neuro-emotional la-bor. If $Y \leq A$, then stage is classified as self-regulation (optimal stress); if $A \leq Y \leq B$, then stage is classified as activation (acceptable stress): if $B \leq Y \leq C$, then stage is classified as I degree mobilization (I degree overstress); if $C \leq Y \leq D$, then stage is classified as II degree mobilization (II degree overstress); if $D \leq Y$, then stage is classified as III degree mobilization (III degree overstress).

Physiological changes index (PSI) is one of the parameters of circulatory system adaptation potential. According to R.M. Baevskiy [4], to assess the adaptive capabilities of the organism in the zone of donor and premorbid states, the method of donor control is designed

Prenosologic states are such states in which non-specific components of body adaptive responses and general adaptation syndrome signs prevail. They are usually characterized with functional stress and unsatisfactory adaptation when normal values of basic vital activity parameters are supported at the expense of increased adaptation mechanisms activity, higher tonus of sympa-thetic nervous system in particular. Long-term stress of adaptation mechanisms and increased consumption of body functional resources (high "price" of adaptation to production factors and social and psychological environmental conditions) lead to lower activity of defense and com-pensatory mechanisms. Specific changes in some organs and systems occur; at first they are not predominant, but further on they become leading and we can confirm that pre-morbid state has appeared; this pre-morbid state later transforms into a specific disease. As R.M. Baevskiy points out [4], pre-morbid states as initial diseases stages can remain for a long time (years), and it is during this period when

basic health-improving activities can be most effective.

As per data given by R.M. Baevskiy [3], strategy of autonomous systems maximum activation takes place on the level of functional reserves mobilization. When their reserves are com-pletely depleted management in a body is provided by central regulation mechanisms. Such management type is characteristic for most nosologic forms. Recovery and rehabilitation processes as well as adaptation to extreme impacts and environmental conditions in labor migrants can be described as gradual transfer from mobilization and activation levels to self-regulation level. As it is shown in works by outstanding labor physiologists, pre-nosologic control is based on determining three components of a body functional state: level of basic physiological systems functioning, their functional reserve, and level of regulatory mechanisms stress.

The level of functioning which is determined as per constant parameters of the most im-portant systems is the least changeable. According to some authors [4,5,9], the level of function-ing is in direct proportion to the degree of regulatory mechanisms stress and is in inverse propor-tion to functional reserves. The higher is the stress degree and the lower is the reserves, the higher is the level of functioning. R.M. Baevskiy [3] developed pre-nosologic control technique based on the level of circulatory system functioning. Circulatory system is known to determine a body's capability to adapt to most adverse factors of working environment. This system plays a most significant role in pre-nosologic states assessment when specific shifts in other organs and systems haven't occurred yet. Here oxygen-feed function of circulatory system can become a leading limiting factor of adaptation. As we know, any functional system in a body consists of subsystems and the ultimate result depends on proper functioning of each such subsystem [9]. If any of subsystems has lower functioning level, reliability of the whole functional systems de-creases considerably. A great number of correlations as well as their numerous interdependences do not always represent this optimal variant which can secure high operating quality and makes for efficient execution of all working tasks.

As per results of our research we studied correlation dependence between psychophysiological parameters determining successful execution of working tasks by labor migrants. These parameters included cardiovascular system ones (heart rate, blood pressure, PSI). heart rate va-riability parameters (SDNN, SI, PARS, TP, VLF, %), neuromuscular system parameters (power, muscle endurance of a working right arm, maximum muscle physical efficiency, endurance of body supporting muscles, MMP). Correlation parameters were authentic ($p \leq 0.05$) at 0.48, i.e. critical value «r» amounted to 0.48. A number of authentic intrasystem correlations amounted to 77.8% in cardiovascular system and to 66,7% in neuromuscular system.

We observed smaller quantity (53.7%) of intersystem correlations between cardiovascular system and neuro muscular system. When examining correlation dependences we noted oc-currence of additional interrelations between physiological parameters in cardiovascular system. It seems that additional correlations become active to provide cardiovascular system functioning. In other words, the greatest number of correlations was detected as per cardiovascular system parameters and it caused high level of adaptation processes stress and increased physiological costs of work.

The research results prove that there is possibility in principle to use the examined para-meters of heart rate variability as physiological markers showing state of regulatory systems stress in labor migrants under exposure to labor hardness factors and labor intensity factors and in adverse social and psychological environment.

Results of studying adaptation as per heart rate variability parameters in labor mi-grants

Scientific literature analysis showed that in 1996 international recommendations headed "Heart rate variability. Standards of measuring, physiological interpretation and clinical applica-tion" were published. Those recommendations summed up previous 20 years of

research and ac-cumulated experience. It was recommended to use 4 frequency ranges in spectral analysis of heart rate variability, namely HF (0.15 – 0.45 Hz) showing para-sympathetic activity of autonom-ous nervous system, LF (0.05 – 0.15 Hz) showing mostly sympathetic branch of baroceptor con-trol. In the authors' opinion, VLF (0.05 –0.005 Hz) had miscellaneous functional significance. Domestic research results as well as results obtained by foreign scientists proved the ne-cessity to correct the recommendations [4]. It was true mostly in respect of VLF range. Re-sults of examin-ing labor migrants revealed that Tadjiks regardless of their sex tended to have authentically ($P<0.05$) higher values of VLF spectrum components (in %) or low waves of the second rank; Russians tended to have higher % of LF component. Comparative characteristics of HRV spec-tral components was performed in groups of migrants from Ta-jikistan and native Russians.

Results obtained at examining people aged 18-20 coming from Tajikistan and Mos-cow region showed that relative contribution of low-frequency spectral waves (VLF%) in migrants from Tajikistan was higher and amounted to 20% while their counterparts from Moscow regions had only 15%. Higher values of VLF component were detected in older Tadjiks, 30.73±3.27% in women and 30.24±2.14 % in men against 24.49±2.92% and 28.39±4.11%, correspondingly. And we should note that regardless of sex and region of origin VLF% grew and HF% went down as age increased; it coincides with data given by other authors. Nowadays it is thought to be well-proven that HF-component of a spectrum, or respiratory waves, is determined by para-sympathet-ic activity whereas LF-component, according to a lot of authors, is related to level of sympathetic system functioning. As for VLF-waves modulation, we can say that their essence is not clear enough and researchers are having heated discussions on the matter. Some authors believe VFL range is closely connect-ed with psycho-emotional stress; VLF can be a good indicator of managing metabolic pro-cesses [11–16].

We should note that an integral parameter of regulatory systems activities (PARS) was authentically lower in Russians ($P< 0.05$ in girls and $P< 0.01$ in boys), which was the evi-dence that Russians were better adapted to ex-treme climatic and environmental conditions in Russia and had greater functional reserves. 60% of examined Russians regardless of their sex had op-timal working stress with PARS values equal to 1-3 points. It corresponded to physiological standard or satisfactory adapta-tion as per functional states classification ap-plied in pre-nosologic diagnostics [4]. At the same time, 70.8% of labor migrants from Ta-jikistan who came to Moscow region had func-tional stress and more apparent regulatory sys-tems stress (PARS was equal to 4 -6 points and more). There were a lot of people with heart rate disorders among them (14.5% girls and 26.8% boys) while there were only 8.3% girls and 14.8% boys with the same disorders among Russians.

It can be explained with increase in LF-component of heart rate in migrants from Taji-kis-tan proving conditioned sympathicotonia occurrence which can later lead to evolvement of dis-eases related to disorders in cardiovas-cular system regulation. As per data given by S.D. Budaev [6], the results of the performed analysis revealed death cases among migrants who came to work in Lipetsk region of the RF; they also revealed higher level of cardiovascu-lar system morbidity among labor migrants from Tajikistan in comparison with Russians. The same author gives some data on death cases.

The detected peculiarities of HRV param-eters (lower general variability, lower values of VLF% etc.) in native citizens of Moscow can be viewed as the result of long-term adap-tation to extreme climatic and environmental conditions of the region which had been last-ing for centuries. It can also indicate that labor migrants from Tajikistan have great difficulty with adaptation to these extreme climatic and environmental conditions. A test with fixed respiration rate was used as functional load on cardiorespiratory system in working process. Functional test with fixed respiration rate

(FRR6, FRR12) is aimed at detecting physiological reserves of cardiovascular activity and body adaptive responses. The research results showed that cardiovascular system response to functional test with fixed respiration rate in Tadjiks migrants was lower in com-parison with Russians living in Moscow region. It also proves there are physiological peculiarities of adaptive responses depending on climatic and geographic conditions of living in high-mountain areas of a donor country providing increased ventilation with oxygen and increased myocardial contractility.

The comparative HRV analysis of labor migrants from Tajikistan belonging to basic oc-cupational groups revealed authentic discrepancies as per a lot of parasympathetic activity para-meters between workers depending on class of labor hardness and labor intensity. Heart rate in the groups didn't have any authentic differences while builders, both erectors and subway build-ers, had lower values of parameters characterizing general heart rate variability: (SDNN) was equal to 41.72 ±1.86 and 41.60 ± 2.01 ms. The obtained data were statistically authentically ($p<0.05$) different from SDNN values detected in fruit and vegetable warehouse workers (labor hardness 3.1) and students of 2nd and 3rd year (labor hardness 2, acceptable), 59.87 ± 1.55 and 55.88 ± 1.70 ms, correspondingly.

Parameters characterizing how active parasympathetic section of autonomous nervous system is are authentically higher (SDNN, RMSSD) at $p<0.001$ and PNN50 ($p<0.05$) for 2nd acceptable labor hardness class and 3rd hazard class with1st labor hardness category correspond-ing to activation stage and 1 degree mobilization stage as per conventional adaptation gradation in comparison with 3rd class with the 2nd and 3rd labor hardness category. Mode amplitude val-ues and stress indices are the evidence that activity of regulation sympathetic section increases as hazard class becomes higher. Here absolute values of these parameters lie within physiological standard range accepted in European authors' research but they are closer to its bottom limit. As a rule, SDNN, RMSSD, PNN50 parameters change in the same direction. Authentic discrepancies in these parameters and in such parameter as MxDMn prove that vegetative balance shifts to pre-valence of sympathetic section of autonomous nervous system on the level of functional reserves mobilization of II and III degree.

Analysis of HRV frequency peculiarities revealed that if labor hardness was 2nd class and 3.1. class such parameters as total power of spectrum TP ($p<0.05$), absolute spectrum power of lower frequency component of variability ($p<0.05$) characterizing vasomotor center activity were authentically lower.

As per scientific literature, central sections of regulatory systems are known to be represented in cardiointervalogram by waves in VLF range [4]. Indeed, we detected that relative power increased in VLF range waves in builders-erectors and builders-steelmen and in subways builders (labor hardness class 3.2-3.3) and it indicated higher activity of sympathetic nervous system. We performed correlation analysis of VLF range spectral power and some working process factors. We observed apparent degree of correlation with emotional load ($r=0.76$, $p\leq0.05$) and labor intensity ($r=0.65$, $p\leq0.05$). We detected lower degree of correlation with integral labor hardness value ($r=0.53$, $p\leq0.05$), and its separate parameters such as static load ($r=0.50$, $p\leq0.05$) and working posture ($r=0.55$, $p\leq0.05$). A great number of correlations between VLF range and several physiological parameters is quite noticeable; these parameters are heart rate ($r=0.75$, $p\leq0.05$), systolic pressure ($r=0.75$,$p\leq0.05$), diastolic pressure ($r = 0.77$, $p\leq0.05$), endurance of a right working arm ($r =0.73$,$p\leq0.05$), MMP ($r=0.57$,$p\leq0.05$), integral parameter of functional state ($r=0.61$, $p\leq0.05$). We determined apparent correlation dependence with PSI ($r=0.84$, $p\leq0.05$), and stress index SI ($r = 0.82$, $p\leq0.05$). As a result we can state that there is a certain interrelation between waves in VLF range and adaptation process.

In R.M. Baevskiy's opinion [3,4] total spectrum power and power in low frequencies range increase at the stage of unstable adaptation and at the activation stage. Activity of

sympa-thetic nervous system increased at the mobilization stage of II and III degree (labor conditions class 3.2-3.3 as per labor hardness and labor intensity). Power in very low frequencies range also grew up.

Centralization index under joint exposure to labor hardness and labor intensity factors at labor conditions class 3.1 amounts to 3.70 ± 0.91 st.units and grow up to 7.58 ± 1.11 and 6.31 ± 0.95 st.units at classes 3.2 and 3.3, ccorrespondingly. It indicates that autonomous functions reg-ulation decreases and the role of central regulation mechanisms becomes greater. In other words, as labor hardness and labor intensity grow, abrupt stress of regulatory systems occurs and, con-sequently, regulation reserves fall. Changes become more apparent at 3rd class with the 3rd cat-egory. According to centralization index dynamics, we can assume that changes in regulation mechanisms take place and it becomes apparent at 2nd acceptable labor hardness class (students) and hazard 3rd class with the 1st category (fruit and vegetable warehouse workers) via relative prevalence of peripheral regulatory centers over central ones; as labor hardness increases, central regulatory mechanisms become more active.

Here mobilization stage is characterized with growing stress index (SI), relative power of VLF% range, decrease in total spectrum power and time parameters of a cardiointervalogram, SDNN in particular. We observed substantial growth in parameter of regulatory systems activity (PARS), up to 6.0 ± 0.40 and 6.21 ± 0.21 st. units, which gave the opportunity to define forming functional state. Here adaptation capabilities of a body could be estimated as a state of regulatory systems overstress which was characterized with defense and adaptive mechanisms insufficiency, their inability to provide adequate body response to impacts exerted by working process factors. And here excessive activation of regulatory systems was not supported by relevant functional reserves [3,4].

Migrants' health state as per objective estimate. To make an objective judgment on influence exerted by production and non-production factors causing morbidity frequency for certain diseases, we analyzed their dependence on time spent by migrants at workplaces in the RF (table 1). medical examinations revealed that if work-ing period was shorter than 1 year acute respiratory viral infections (ARVI) (40.8%) and chronic bronchitis (38.1%) prevailed. But as time passed by, migrants adapted to living and working conditions, and by the end of their third year of staying in various Russian regions ARVI and chronic bronchitis morbidity went down. At the same time, as working period grew longer, a number of spinal column diseases also increased and it was a consequence of migrants being employed at hard work (lifting and moving loads, work in a forced working posture etc.).

Gynecological morbidity level in female migrants depended on labor hardness and labor intensity factors. It was shown that if etiological share of contribution made by adverse working process factors into female diseases evolvement amounted to 40-50% then degree of correlation between diseases and work was average or strong, i.e. a disease was occupationally induced.

Table 1

Prevalence of pathologies in migrants depending on working period (%)

Disease	Working period, years			
	Shorter than 1 year	1–2	2–3	3 and longer
ARVI	40,8	32,6	22,3	12,02
Chronic bronchitis	38,1	33,6	12,1	8,9
Spinal column osteochondrosis	6,8	28,8	22,3	22,0

Here we revealed some discrepancies in terms of extent to which adverse work influence became apparent. The first place belonged to female organs prolapse and ptosis due to hard physical labor mostly in standing position (EF was equal to 56.4% in female migrants in comparison with control group).

Table 2

Risk of occupational pathology evolvement depending on working process hardness (%)

Type of mus-cle loads	Working process hardness (as per P 2.2.755-99)				
	1 class optimal	2 class, acceptable	3 class, hazardous (hard labor)		
			1 degree	2 degree	3 degree
Regional and basic	0–6,0	6,1–17,0	17,1–28,0	28,1–37,0	Более 37,0

Table 3

Risk of occupational pathology evolvement (primary hypertension, ischemic heart disease and neurotic disorders) depending on labor intensity degree (%)

Pathologies	Labor intensity degree				
	I-low inten-sity (1)	II- average intensity (2)	III- high in-tensity (3.1)	IV- very high intensi-ty (3.2)	V- exhaust-ing intensity (3.3)
Primary hyper-tension	0	0,1–10,3	10,4–20,7	20,8–29,1	29,2–36,2
Ischemic heart disease	0	0,1–6,1	6,2–21,2	21,3–33,5	33,6–43,8
Neurotic dis-orders (total number)	0	0,1–11.1	11,2–24,2	24,3–34,9	35,0–43,9

Menstrual function disorders (EF was equal to 55.3%) and inflammatory diseases of female pelvis organs (EF was equal to 45.7% in female migrants in comparison with control group) occupied the second place. Customary miscarriage and infertility took the third place.

Hard physical (muscle) labor causes greater risk of occupational diseases evolvement in musculoskeletal system and peripheral nervous system. We analyzed data of physiological and clinical examination performed on a great number of people and it allowed us to detect that occupational MSS and PNS diseases frequency in studied occupational groups depended on working process hardness (table 2).

Neuro-emotional labor intensity was considered to be a risk of production-induced diseases. Various disorders in cardiovascular system are known to evolve under apparent neuro-emotional loads; such disorders include primary hypertension and ischemic heart disease. Mental stress at shift work and longer working period causes neurotic disorders evolvement. As per pro-duction research results we detected health risks depending on labor intensity degree (table 3).

High morbidity among labor migrants from Tajikistan leads to substantial economic losses. As we undergo transition period to market economy issues of preventive measures and therapy for them become really vital since migrants' health is a criterion of human factor efficiency in production process.

So, labor migrants' health is influenced by both external and internal risk factors such as climatic and ecological, social, and neuro-emotional ones; these factors can cause various infec-tious and non-infectious diseases evolvement.

To preserve labor migrants' health and secure their high physical efficiency, we worked out medical and social support activities which form the 3rd subsystem in the whole system theory. Preventive activities are aimed at migrants' social provision, carrying out educational events, organizing professional selection and professional orientation, creating rational work-rest regimes, performing treatment-and-diagnostics events, making supplements into legislative measures regulating labor migrants' work.

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METHODS FOR ASSESSING THE AWARENESS LEVEL ABOUT HIV INFECTION RISK FACTOR AMONG STUDENTS OF THE KHABAROVSK KRAI

I.O. Taenkova[1], O.E. Trotsenko[1], L.A. Balakhontseva[1], A. A.Taenkova[2]

[1] Khabarovsk research institute of epidemiology and microbiology of Federal service for surveillance on customer rights protection and human wellbeing, 2 Shevchenko Str., Khabarovsk, 680610, Russian Federation
[2] Khabarovsk regional association «Health and family», 20 Pereulok Dzerzhinskogo, 281 ldg., 680020, Khabarovsk, Russian Federation

To prevent the social diseases, including HIV infection – is one of the high-priority tasks of the public health. To assess the awareness level among the students of the Khabarovsk Krai in the age of 17–20 years about the risk factors and the HIV transmission ways, the special investigation has been held in 2016. The method of selection of respondents was random. The sampling included the first-year students of two universities and one college in the city of Komsomolsk-on-Amur (120 pers.) and two high schools and college in Khabarovsk (100 pers.). The average age of respondents was 19.2 ± 1.04 years. The distribution by sex: men – 33 ± 3.17 %, women – 67 ± 3.17 %. The comparison of the data of the previous years (2008, 2012) and the study in 2016 confirmed that the majority (92 ± 1.5 %) of the surveyed young adults in general are well-informed about HIV, sexual and parenteral routes of transmission. However, in recent years, the share of those who consider the possibility of HIV transmission through kisses, bites of blood-sucking or by sharing a meal. The performed studies have confirmed the tendency of the younger generation to the risky behavior. Their search for novelty and the thrills can be traditionally considered to be a contributing factor to the experiments with psychoactive substances and early initiation of sexual relations. The conducted analysis has showed the possibility of using the various forms and methods of youth behavior research. The study has revealed a certain potential for preventive planning of primary prevention of HIV infection. The obtained results have demonstrated that for the effective containment of the HIV epidemic it is necessary to carry out continuous risk monitoring system and preventive work among all young people, not only among the vulnerable groups.

***Key words**: HIV infection, awareness, situation monitoring, risk of transmission, young adults, prevention.*

Preserving young people's health and prevention of social diseases spread, including drug addiction and HIV-infection, are priority tasks of public healthcare.

An issue of HIV contagion risk among young people is always vital as young people aged 14-30 are a population group who are going to pursue their course of life, choose a career, build a family, give birth to children, and, in doing so, improve social, economic, and demographic situation in our country. To detect unfavorable epidemiologic situation and to work out relevant prevention activities we need to apply a specific system of epidemiologic risks manage-

Irina O. Taenkova – Researcher of the Laboratory for prevention of viral hepatitis and AIDS of the Far Eastern Regional Center for Prevention and Control of AIDS (e-mail: aids_dv@mail.ru; tel.: +7 (421) 225-31-85).

Olga E. Trotsenko – MD, Director (e-mail: trotsenko_oe@hniiem.ru; tel.: +7 (421) 232-52-28).

Lyudmila A. Balakhontseva – Head of the Far Eastern Regional Center for Prevention and Control of AIDS (e-mail: balahonceva-la@list.ru; tel.: +7 (421) 221-66-39).

Alina A. Taenkova – PhD, scientific advisor (e-mail: docanna27@yandex.ru; tel.: +7 (421) 221-66-39).

ment. Morbidity index is a basic one showing HIV spread level. However, it doesn't always give an opportunity to react promptly as related data become available only in a certain period of time (a quarter, a year) [1, 9,16].

Unified complex approach to assessing epidemiologic situation, various factors and subjects of administrative impact allows to form target groups for preventive activities in the sphere of HIV infection spread [2,6]. Risk of catching sexual diseases and HIV-infection is especially high among young people. If we understand the awareness level and certain attitudes towards prevention of so called behavioral diseases among rising generation, we can plan educational activities and predict prevalence of socially significant diseases as well as apply other preventive measures [8,21,22]. A lot of publications in domestic literature [4,5,6,9,10,23] as well as the authors' own data [12,13,15] confirm the fact that studying level of knowledge on risks of catching HIV-infection is vital. Here it is very important to perform comprehensive analysis of changes which occur in diseases prevalence and awareness of the population about risks of their evolvement; it is also important to compare all obtained data with data from previous periods etc. [9,11,13,14].

It becomes essentially vital to develop policy in the sphere of resistance to HIV-infection spread and to implement complex prevention programs aimed at mitigating medical-social and economic consequences of this social pathology. Here specialists treat effectiveness of prevention programs and medical-social programs and the educational effect level as correlated categories [3].

Hygienic education and medical-social education are very important tools for achieving epidemiologic welfare of the population. Activity in this sphere requires constant search for new information technologies which meet the contemporary challenges, population needs and needs of the country as a whole [4,18,23]. To work out prevention strategy and information and education activities methodology we require not only data on pathological affection but also social and psychological data. And here studying behavioral patterns with the consequent comparative analysis of the obtained data and data from previous periods is of primary importance.

Our research goal was to assess level of awareness which young students (aged 17-20) in Khabarovsk region had of risk factors and ways of catching HIV-infection. To do this, we applied a combination of social techniques and social and psychological ones.

Data and methods. Traditionally, level and dynamics of HIV-infection morbidity are analyzed on the basis of state statistic reports as well as via performing various studies of behavioral practices. The authors have accumulated certain experience in collecting and analyzing the data which are necessary to work out a preventive strategy and to plan medical and sanitary education on decreasing prevalence of social diseases among young people [15].

Figure represents a scheme of various forms and techniques which give the opportunity to assess level of young people's awareness of HIV-infection contagion risks directly or indirectly.

To carry out research in 2016 we used formalized questioning technique among young students in two cities of Khabarovsk region, namely Khabarovsk and Komsomolsk-na-Amure. 220 first-year-students from educational establishments of higher education and secondary vocational education aged 17-20 were our research object. We chose our respondents randomly. Our sampling included first-year students from two higher education establishments and one technical college in Komsomolsk-na-Amure (120 people) and two higher education establishments and one technical college in Khabarovsk (100 people). Average age of the respondents amounted to 19.2 ±1.04 years. Distribution as per sex was as follows: 33%±3.17 males, 67%±3.17 females.

We used a structured questionnaire as our toolset; it consisted of 17 multiple choice questions, each having from 3 to 7 answer variants. Questions were divided into two groups; the first one was dealing with HIV infection epidemiology and was related to contagion ways, risk behavior (taking psychoactive drugs, early sexual contacts with often change of partners etc.); the second group contained

social and psychological questions aimed at detecting attitudes towards safe sexual behavior, being ready to use protective measures and to be regularly HIV-tested. Besides, we analyzed social and demographic features of our respondents (sex and age).

We used some supplementary techniques; they included specialized exercises and tests and solving subject crosswords which we had previously tried out during some events dedicated to World Health Day, for example subject classes delivered as per requests from educational establishments of Khabarovsk city. 122 students took part in our research; they all were first-year-students; their average age was 17.1±0,9, and they all were chosen randomly. This research stage was accomplished in order to try out and confirm efficiency of applying indirect techniques when assessing level of awareness about HIV infection. We obtained the data on level of knowledge about HIV contagion ways.

To perform comparative analysis we used data obtained during sociological questioning conducted in 2008 and 2012 with the use of the same toolset and also with the use of other techniques aimed at studying awareness among young students in Khabarovsk region (first year students of HEE and technical colleges in Khabarovsk and Komsomolsk-na-Amure) shown in Figure. The research was accomplished by Regional Youth Social Medical-Pedagogical Center; the results were included into a number of monographs and scientific articles [1,11,12]. 500 first-year-students from two HEE and two technical colleges in Komsomolsk-na-Amure and three HEE and two technical colleges in Khabarovsk took part in 2008 research; in 2012 300 students from the same educational establishments participated in questioning (average age was 17.8±0.6 years).

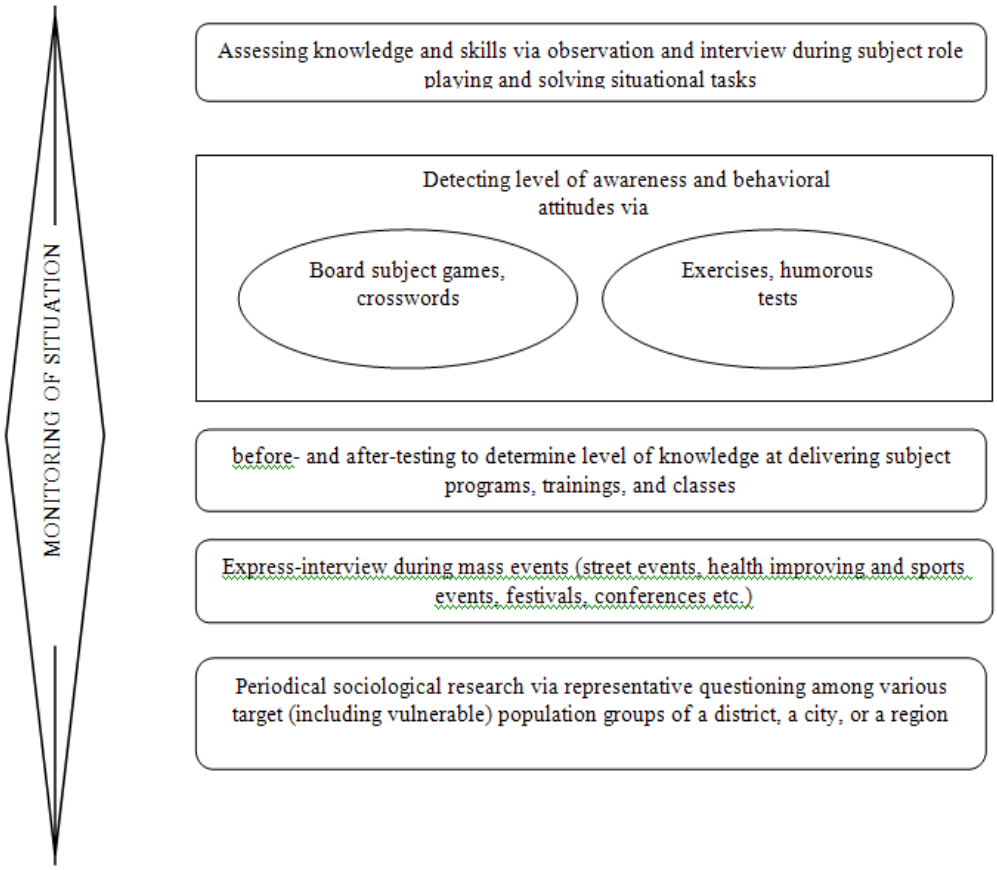

Figure. Forms and methods to assess level of awareness about HIV-infection among young people

Research results. As we compared the data from previous periods and data obtained in 2016, we saw that rising generation were really prone to risky behavior. Searching for novelty and thrills is traditionally considered to be a factor making for experiments with psychoactive drugs and early sexual contacts. For example, we can assess health risk as per variants suggested as an answer to a statement "You should try out everything in this life!". 29.0±2.52% respondents were ready to put their health at risk, 27.0±2.45% had doubts about that, 41.0±1.65% said it was completely untrue for them (2012).

Comparative analysis results revealed both positive changes and absence of them, and we understand that constant attention to young people's awareness of HIV infection spread issue is required.

Most young respondents (92.0±1.53%) in the latest research (2016) were well aware of HIV infection choosing answer "yes, I know this infection; one can catch it and become ill with AIDS".

The research conducted in 2016 and comparison with the data obtained in 2008 revealed good awareness of sexual and parenteral (via blood) ways of HIV-infection contagion among young people. However, only 60.0±2.65% respondents knew there was also "vertical" (perinatal) contagion way. Despite all this, the awareness level among students about parenteral, sexual, and vertical way of contagion increased in 2016 in comparison with 2008 (Table 1). But it is quite alarming that over the last years the number of those believing one can catch HIV via kisses, bites of blood-sucking insects, or when sharing a meal, has been growing.

We should point out that in spite of high level of awareness about basic ways of HIV-infection contagion a great number of respondents in 2016 turned out to have phobias and to have little information about life with HIV. For example, when answering a question "Would you shake hands with a HIV-infected person?" 25.72±2.42% had doubts about that, and 4.71±1.17% said it was completely impossible. Up to 36.0±2.66% respondents wished to keep their distance from HIV-infected people, and 19.0±2.17% would be greatly concerned at having such s person in their group.

Table 1

Frequency of respondents' answers about possible ways of HIV-infection contagion (in %, in different years)

Questions	Frequency (in %) of positive answers given by respondents		*p* Probability of errors in parameters
	2008 (*n* = 500)	2016 (*n* = 342)	
Average age	17,9 ± 0,5	18,15 ± 0,8	
Ways of HIV infection contagion:			
– sexual	86,0 ± 1,54	92,8 ± 1,39	*p*<0,001
– parenteral (through blood)	87,0 ± 1,51	99,0 ± 0,53	*p*<0,001
– perinatal (vertical)	45,0 ± 2,21	60,0 ± 2,65	*p*<0,001
– through bites of blood-sucking insects	20,0 ± 1,78	27,3 ± 2,41	*p*<0,05
– via kisses	14,0 ± 1,54	20,9 ± 2,19	*p*<0,01
– when sharing a meal	2,0 ± 0,62	17,81 ± 2,04	*p*<0,001

Table 2 contains data on dynamics in distribution of young people's answer to a question "What is necessary to prevent catching HIV-infection?" over years; as we can see from this table, level of awareness about various efficient protection measures has grown.

Table 2

Distribution of young people's answers to a question «"What is necessary to prevent catching HIV-infection?" (in %, over years)

Variants	Share (in %) of respondents, who chose this variant		
	2008 г.	2012 г.	2016 г.
To avoid taking drugs	24,0 ± 1,91	49,9 ± 2,88	59,0 ± 2,73
To have one healthy partner and be faithful to him/her	29,0 ± 2,02	60,81 ± 2,81	54,72 ± 2,76
To use condoms	48,0 ± 2,23	53,72 ± 2,87	52,61 ± 2,77
To observe rules of personal hygiene	51,0 ± 2,23	45,41 ± 2,87	41,32 ± 2,73

Note: students were allowed to choose not more than 3 variants of an answer

Nowadays, more than a half respondents mention such priority prevention measures as giving up psychoactive drugs (59.0±2.73%), necessity "to have one constant healthy sexual partner and to be faithful to him/her" (54.72±2.76%), using condoms to protect oneself from contagion (52.61±2.77%). It is quite remarkable that a share of students who believe that "you should stop taking drugs if you want to avoid HIV-infection" has grown considerably, from 24.0±1.91% in 2008 to 59.0±2.73% in 2016 ($p<0.001$).

In our opinion, there are several reasons for that. First, it is due to complex large-scale prevention activities which took place in the region and were performed by prevention system establishments together with law enforcement structures in 2008-2015. Secondly, young people mostly changed drugs they tended to take and ways of their introduction (they switched from intravenous introduction to taking synthetic peroral drugs and smoking mixtures / spies which were more available for young people).

A share of respondents believing it was necessary to "have one healthy sexual partner and be faithful to him/her" has increased considerably in 2016 in comparison with 2008 ($p<0.001$). We can also trace a positive trend to have more responsible attitude towards one's health in using condoms. Young people have quite satisfying knowledge about condoms as a means to reduce HIV-infection risks (the share grew from 48.0±2.23% in 2008 to 52.61±2.77% in 2016 of total number of respondents); this knowledge partly transforms into safe behavior. Thus, as per questioning results, the share of young people who permanently used such protectors grew from 7.52±1.17% in 2008 to 45.15±2.69% in 2016 (of total number of respondents, $p<0.001$).

So, the share of those who permanently use condoms as a means of protection from HIV contagion is relatively high; but still, up to 29.82±2.47% young people questioned in 2016 chose the answer "I don't need it", and 4.13±1.07% considered that "condoms can't protect from HIV". 11,25±1,72% respondents used condoms "only when having suspicious contacts".

Regular testing can be considered a prevention measure against HIV-infection spread; scales of such testing have grown over the last years. Most young respondents (72.0±2.82%) questioned in 2016 had HIV testing, and 52.0±2.7% of them did it in the last six months. The rest 28.0±2.16% respondents chose the answer "yes, but I don't remember when I did it". 14,12±1,88% were ready to have such test when asked during questioning ("I would have it but I wasn't offered to do it"), and 11.23±1.71% respondents chose the answer "I don't need it".

Therefore, the obtained data revealed satisfactory level of awareness about basic ways of HIV-infection contagion (sexual and parenteral one). However in the course of our research we detected that population still had some stereotypes. Thus, up to 15±3.23% respondents in 2016 thought it dangerous to share a meal with a HIV-infected person, and 23±3.8% believed one could catch HIV through bites of blood-sucking insects.

It is next to impossible to conduct large-scale sociological research annually; but it is quite possible to apply various techniques described in this article which are more available and can be aimed at monitoring of the situation. Such monitoring is necessary for prompt responses when implementing systems of primary prevention activities and detecting most vulnerable age or social group who are priority target for educational activities.

Conclusions. Analysis of the level of awareness among young people about possible ways of catching HIV-infection proves potential efficiency of medical and sanitary education. Most young people, just like in previous years, are well aware of basic ways of HIV-infection contagion. At the same time we are worried that there are still myths existing in young people's minds telling that it is possible to catch HIV via kisses or bites of blood-sucking insects. It calls for paying greater attention to destruction of such myths when implementing prevention programs. It can be

achieved through situational role-playing and application of various exercises / role-playing games. There is additional reserve in using HIV-testing as a prevention technique.

The novelty of our last research can be seen in detection of certain prevention potential which recognized risks have in terms of primary prevention against HIV-infection contagion. Thus, most young people assign top priority as per protectors rating scale to such convictions as "to have one constant healthy partner and to be faithful to him/her", "to give up taking drugs", and "to use condoms" (54.72±2.76%; 59.0±2.73%; 52.61±2.77% correspondingly). Up to 33.9±2.55% respondents still don't see any relation between protection from HIV and the necessity to permanently use condoms. Mostly girls and young women had little interest in using condoms.

The success of prevention activities against HIV-infection spread depends on their coordination. There is no universal algorithm of prevention activities. However, it is possible and, moreover, necessary to work out common approaches to organizing and carrying out such events [7]. Coordination aiming of prevention activities at all groups in prevention system underlies most successful prevention strategies. The obtained results again revealed that to restrain HIV epidemic efficiently, it is necessary to conduct continuous risks monitoring among all the young people and not only among most vulnerable population groups. And here medical and sanitary education should be aimed at both formation of spiritual, moral, and family values, and safe sexual behavior with correct use of protectors against HIV.

The performed analysis showed efficiency of various techniques applied in the course of studying behavioral practices in order to determine further management decisions which are needed to reduce risks of HIV-infection contagion among young people.

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MEDICAL AND SOCIOLOGICAL EXPLICATION OF THE PROBLEM OF INFECTIOUS DISEASES PROPHYLAXIS AMONG PREGNANT WOMEN

N.B. Merzlova[1], I.A. Serova[1], A.Yu. Yagodina[2]

[1]Perm State Medical University named after E.A. Wagner, 26 Petropavlovskaya Str., Perm, 614990, Russian Federation
[2]Perm City Outpatient Clinic, 45 Permskaya Str., 614000, Perm, Russian Federation

The research is focused on revealing the TORCH-infections prophylaxis problems during preconception period and culture of personal infection safety among pregnant women. The research involved 2060 women. Epidemiological monitoring was accompanied by a social survey of the Perinatal Center patients using the continuous sampling method. The problems of the population's response adequacy regarding the dangers of TORCH-infection are presented on the basis of questionnaire survey of 55 pregnant women – patients of the Perinatal Center. Sociological explication of the problems of TORCH-infections prophylaxis revealed the positive and negative behavioral stereotypes of the Perm Region population from the point of view of assuring the personal infection safety. The positive stereotypes include cleanliness and vitamin prophylaxis practice. The regional hygienic culture can be developed by increased involvement in sport, immunological prophylaxis propaganda, safe sex, helminth prophylaxis in pets and regular tooth brushing. The survey has explicated the common negative behavour stereotypes leading to toxoplasmosis contamination during pregnancy. Only a half of the surveyed women avoid the intake of meat that did not undergo sufficient heat treatment, 72.7 % of respondents cannot be relieved from the duties of cleaning the cat's toilet. The rating made on the basis of the survey concerning the popularity of measures assuring personal infection safety has shown a neglectful attitude of population towards the immunological prophylaxis and modern medical products affecting the immune system, that inevitably leads to problems with compliance of pregnant women to vaccination and immunological correction by immune modulators during treatment of the revealed infectious diseases. We found a mismatch between the behavioral stereotypes of the Perm Region population in ensuring personal infection safety and the academic principles of TORCH-infections prevention, that shows a persisting danger of vertical TORCH-infections transmission and requires efforts aimed at increasing the expertise of the population in TORCH-infections prophylaxis during preconception period.

***Key words**: TORCH-infections, infection safety, behavioral stereotypes, pregnancy infections, vertical infection transmission route, vaccination, immunological correction.*

If we want to personify risks related to providing infectious safety during pregnancy, labor, and newborns nursing, we should be aware that this problem has three aspects, namely, medical one (infection risk and risk of infectious diseases evolving); economic one (costs of vaccination prevention, laboratory diagnostics, costs of nursing and social rehabilitation of newborns with grave infectious pathology); humanitarian one (safe nutrition stereotypes and safe behavioral stereotypes). Risks occur due to uncertainty and inability to see the future. If we model the future we can achieve mental decrease in risk level and thus make our anxiety level also lower. Being competent in providing personal infectious safety is a means of infectious and parasitic diseases prevention, and such prevention decreases both risk of transferring infection / invasion agents and risk of a disease evolvement.

Nina B. Merzlova – Doctor of Medical Sciences, Professor, Head of the Hospital Pediatrics Department (e-mail: nmerzlova@yandex.ru; tel.: +7 (342) 221-86-15).

Irina A. Serova - Doctor of Philosophy, Professor, Professor of the Philosophy and Biological Ethics Department (e-mail: berrymoor@perm.ru; tel.: +7 (342) 281-74-81).

Anna Yu. Yagodina - Candidate of Medical Sciences, Infectiologist of the Primary Specialized Health Care Division (e-mail: annayagodina@rambler.ru; tel.: +7 (342) 212-82-44).

Which infections can exert negative influence on pregnancy? They are malaria, leptospirosis, and clamidiosis, as they lead to preterm labor and miscarriages. Cytomegalovirus infection (CMVI), toxoplasmosis, herpetic infection caused by HSV, rubella, chicken pox, and clamidiosis, exert negative influence on a newborn health. These infections can cause children malformations given in Table 1.

Table 1

Children malformations caused by TORCH-infections

Malformations	Toxoplasmosis	Clamidiosis	Rubella	CMVI	Herpetic infection	Chicken pox
Brain damage (microcephalia)				*		
Brain damage (hydrocephalus)	*					
Deafness				*		
Rash				*	*	*
Eyes damage (chorioretinitis)	*			*	*	*
Multiple malformations			*			
Liver damage (hepatitis)	*			*	*	
Conjunctivitis		*				
Pneumonia		*				

Toxoplasmosis, clamidiosis, rubella, CMVI, all so-called TORCH-infections can often have no symptoms in pregnant women but they cause fetus malformations. Some infections can be transferred from a mother to a child and infect it, for example, with HIV-infection, viral hepatitis B and C.

What are the main ways of transferring infections which are dangerous during fertility? Toxoplasmosis can be caught at eating raw minced meat or poorly roasted meat, and at cleaning up cats' toilets. CMVI and HSV are droplet infections and can be caught through kisses, talks at close distance, and in a sexual intercourse. Chicken pox and rubella can be caught only in a droplet way while hepatitis B and C and HIV infections are transferred via sexual contacts and parenteral way.

Vaccination is a preventive measure against hepatitis B and rubella. Prevention measures against CMVI, HSV, and chicken pox include having no contacts with small children during pregnancy, keeping away from pre-school children facilities and children polyclinics.

M.Yu. Surmach [8] proved, that if a level of a woman' prevention activity during pregnancy was low, it had negative influence on a newborn health. In particular, it was detected that % of intrauterine infections among women who fully completed pregravid preparation was substantially lower than among those who didn't get themselves ready for pregnancy at all (0.2% against 4.6% correspondingly).

Our research goal was to reveal problems existing in TORCH-infections prevention during pregravid preparation. Application of sociological techniques in order to determine personal infectious safety culture among pregnant women being elements of epidemiologic process helps to analyze safety measures against TORCH-infections vertical contagion used in private life. Our research goal was to define how competent our population were in TORCH infections prevention issues.

Practical value. New data which we obtained on self-preserving behavior of the region population can be applied in implementing Perm region state program "Health care development" (Subprogram 1 "Diseases prevention and formation of healthy lifestyle. Development of primary medical and sanitary aid" and Subprogram 4 "Health protection for a mother and a child"). In particular, if we realize that population awareness is low it will help to reduce prevalence of significant factors causing diseases risks (Task 5 in Subprogram 1); if we optimize diseases prevention strategies it will lead to improvements of mothers' health (task 2 in Subprogram 4).

Patients and techniques. Since 2001 all pregnant women in Perm region have been examined in order to detect TORCH-infections during observation over pregnancy. Most pregnant women receive their examination results in perinatal center of State Budgetary Healthcare Establishment "MSCH No.9 named after M.A. Tverjie". We performed retrospect research on TORCH-infections prevalence among pregnant women in this perinatal center from June 2010 till December 2013. Our research comprised 2,600 women [5]. epidemiological monitoring conducted during all March 2013 was combined with sociological questioning among perinatal center patients via universal sampling technique. Problems related to how relevantly our population reacts to dangers represented by TORCH-infections are highlighted in the results of questioning comprising 55 pregnant women - perinatal center patients. This questioning enabled us to determine personified respondents' attitudes towards infectious safety during pregnancy and preparation to it.

Results and discussion. The conducted questioning aimed at examining behavioral peculiarities of pregnant women revealed there were information problems in intrauterine infections prevention. Only 14.2% respondents gave correct answers to a question "What infections can have negative influence on pregnancy since they can cause preterm delivery or miscarriage?". But the next question, "What infections can lead to malformations?", caused less puzzlement and 56% pregnant women gave correct answers. We should note that incorrect answers to the first question (54.5%) were mostly due to high degree of phobia which exists in respect to HIV-infection and hepatitis and as for other infections and invasions they are considered to be quite curable [3].

Questioning results allowed us to draw up a popularity rating for measures aimed at providing personal infectious safety (Table 2) which confirmed the existing behavioral stereotypes of Perm region population as it coincided with the preferences which we had revealed a year before [4]. It is obvious that a lot is to be done in developing hygienic culture of the region population and the tasks include greater involvement of the population in sports, immunoprophylaxis propaganda, propaganda of safe sex, and prevention of helminthes in pets.

Table 2

Popularity rating for measures aimed at providing personal infectious safety

No. in rating	Measures aimed at preventing infectious and parasitic diseases	Quantity of positive answers in %
1	Wash my hands thoroughly	92
2	Wash berries, fruit and vegetables thoroughly	84
3	Take vitamins	73
4	Don't eat raw or insufficiently heat-treated meat and fish (raw frozen fish, dried fish, raw minced meat, river fish caviar which was prepared at home)	73
5	Follow all rules and terms of food staffs keeping	71
6	Try to avoid contacts with sick people	68
7	Don't gnaw my nails	64
8	Brush my teeth twice a day	61
9	Drink only boiled water	61
10	Wear gauze bondages during flu epidemic	36
11	Have only safe sex	33
12	Use oksolin (naphthalene-1,2,3,4) ointment	31
13	Apply prevention measures to protect my pets from helminthes	21
14	Do sports	19
15	Have vaccination against tick-borne encephalitis	15
16	Have vaccination against hepatitis B	15
17	Have vaccination against rubella	14
18	Have vaccination against flu	12
19	Add biological additives to my food	7
20	Take immune modulators (eleutherococcus tincture, ginseng tincture, cycloferon, panavir)	5

Questioning revealed there were behavioral stereotypes providing toxoplasmosis prevention during pregnancy. 96.3% respondents answering the question "Which additional preventive measures against infectious and parasitic diseases are necessary during pregnancy?" told it was necessary to completely exclude raw minced meat and poorly heat-treated meat from the ration; 61.8% thought it necessary to "delegate" cleaning up cats' toilets to someone else in the family. However, the next question, "Which of the measures you've just mentioned do you personally implement in your everyday life?", revealed that only half of the respondents really didn't eat insufficiently heat-treated meat. As for taking care of pets, even smaller number of pregnant women complied with their own attitudes; 72.7% of them couldn't get rid of cleaning up cats' toilets. Half of the respondents had cats in their families and only 14.5% of the questioned pregnant women followed their hygienically justified attitudes towards toxoplasmosis prevention in their everyday life.

Carelessness in respect to toxoplasmosis prevention is determined by population unawareness about main child malformations [1] which can be caused by this invasion; according to our questioning results only 9.6% were aware of a newborn hydrocephalus risk, only 9%, chorioretinitis risk, and 3.6%, hepatitis risk, correspondingly.

History of acute toxoplasmosis treatment proves that treatment period tends to become longer, and set and doses of taken drugs increase. Recent multi-centered research highlighted the issues of treatment efficiency during pregnancy [9, 10]. Levels of infection transferring from a mother to a child in groups receiving only spiramycin, pyrimethaminum, sulfadiasinum, folic acid or pyrimethaminum, sulfadiasinum with spiramycin or another atypical treatment didn't have any substantial discrepancies [12]. Chemotherapy doesn't provide full sanation of a body from the agent as it settles inside cells in tissues and it is difficult to affect it with drugs.

Alternative views on toxoplasmosis treatment efficiency during pregnancy make researchers look for compromise treatment. For example, monthly examination of pregnant women allows to make a period during which treatment starts a bit shorter. Amniotic fluid examination with the use of polymerase chain reaction helps to exclude a fetus infection and thus makes it unnecessary to take sulfadiasinum or pyrimethaminum during pregnancy [11]. As there is no consensus in respect to toxoplasmosis treatment principles prevention issues become really vital. Toxoplasmosis prevention principle for pregnant women is determining serological status in each woman who is going to conceive in order to detect infected ones and to provide others with information on how this invasion can be caught. In our opinion, principle of personal responsibility which a mother has for her child safety is the most efficient one; this principle means complete and strict prohibition on eating raw meat and on cleaning up a cat's toilet during pregnancy.

Droplet way of catching CMVI, HSV, chicken pox, and rubella, causes objective difficulties in these infections prevention and raises rhetorical questions: should we really explain a pregnant women that it is necessary to avoid contacts with small children, intimate talks or kisses during her pregravid period? Should we explain how to solve a dilemma between safe sex and conception? The only thing which is certain about prevention of droplet TORCH-infections is obligatory vaccination against rubella. It is also necessary to get vaccinated against measles during preparation to pregnancy. If you had vaccination from diphtheria and tetanus 10 years ago it is advisable to have re-vaccination.

Epidemic situation concerning hepatitis B in many regions is also an argument for immunoprophylaxis. We'd like to note that vaccination occupies next to last places in popularity rating for measures aimed at providing personal infectious safety according to our questioning. Only 27.2% respondents get vaccinated against tick-borne encephalitis and hepatitis B; 25.4%, against rubella; 21.8%, against flu. And we should point out that pregnant women who are contact as per hepatitis B

and who don't have detected HbsAg ought to be vaccinated against hepatitis B. It is very useful to inform women that most vaccines can be dangerous for a fetus only in theory. So, if a real risk to catch diphtheria, tetanus, hepatitis A and B, flu, or poliomyelitis, exists, it is quite possible to get vaccinated during pregnancy.

In addition to immunoprophylaxis we can find other spheres which were detected in the course of our questioning and where personal protection of population from infection risk can be improved. For example, talks on immune deficiency of various etiology can be very productive as we can treat it as a target for TORCH-infections prevention during period of preparation to pregnancy [2]. Traditional neglectful attitude (confirmed also by our questioning) towards immune modulators may need revision. Why taking vitamins is on the third place in popularity rating for measures aimed at providing personal infectious safety, and taking immune modulators occupies the last one? Is this population behavioral stereotype consistent with scientific research results? For example, V.N. Prilepskaya, A.V. Ledina and N.A. Korotaeva in their article analyze the results of a snap clinical multi-centered controlled research of Panavir drug safety and tolerance for pregnant women during II and III trimester [7]. It was detected that if Panavir drug was included into complex therapy of CMVI acute condition it efficiently resulted in reduction in titer of immunoglobulin G and prevented newborns' infection; it was safe both for a mother and a fetus; it didn't have any side effects and didn't lead to unwanted consequences. Immune modulators are also widely used to prevent herpetic infection recurrences. Neglectful attitude of population towards immunoprophylaxis as well as towards modern drugs influencing immunity which we detected unavoidably leads to problems of pregnant women' compliance with vaccination and immunocorrection with immune modulators in case of detected infectious diseases (CMVI, HSV).

Sociological explication of medical problems can have no purpose and serve only as a supplementary research product in various perspectives detecting population behavioral stereotypes. Sociologists most frequently register features of moral status which medical organizations have; features of moral attitude which doctors and patients have; features of ethical relationships culture in medicine [6]. In our opinion, sociology can be efficient in solving specific medical problems, particularly, problems of patients' compliance with treatment. Medical-sociological questionings during visits to a doctor obviously perform prevention tasks via sanitary-hygienic education and have a positive influence on self-preserving behavior of region population.

Conclusion. We detected inconsistence between behavioral stereotypes of Perm region population in the sphere of providing personal infectious safety and academic principles of TORCH-infections prevention. It means there is still a danger of TORCH-infections vertical contagion and some efforts are required which will increase population awareness as regards TORCH-infections prevention during pregravid preparation.

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SANITARY-EPIDEMIOLOGICAL AUDIT IN RUSSIA AND ABROAD: CHALLENGES AND GROWTH PROSPECTS (ANALYTICAL REVIEW)

I.V. May[1], E.V. Sedusova[1], T.M. Lebedeva[2]

[1]Federal Scientific Center for Medical and Preventive Health Risk Management Technologies, 82 Monastyrskaya Str., Perm, 614045, Russian Federation
[2]Perm State Medical University named after E.A. Wagner, 26 Petropavlovskaya Str., Perm, 614990, Russian Federation

The shaping the system of control and surveillance activities in the Russian Federation, which affects the bodies of the sanitary-epidemiological surveillance, requires the development of new forms of cooperation between authorities and legal entities, individual entrepreneurs and population. Such a form may be represented by the sanitary and epidemiological audit as an independent objective assessment of reputable third parties. The audit is intended to check the compliance with the mandatory requirements of the economic entities, performing economic or other activities. The sanitary-epidemiological audit may be associated with a system of certification for compliance with sanitary requirements and may assume the documented confirmation of the compliance issued by the authorized persons.

The sanitary-epidemiological audit and the compliance certification to mandatory sanitary requirements can make an alternative to the planned supervision activities on facilities attributed to the category of low and moderate risk of harm to human health. The Russian sanitary legislation does not recognize the sanitary-epidemiological audit as a form of conformity assessment. The analysis of the international experience shows that it is necessary to consolidate the general rules and regulations of the sanitary-epidemiological audit at the legislative level and to develop a set of sublegislative documents in order to implement these norms. The crucial is a creation of the national system capable to regulate the registration and functioning of the organization having a right to conduct the audit activities in the field of hygienic safety. It is reasonable to develop the regulation on the list-register of auditors and to create a special training system for the auditors, who possess the methodology for health risk assessment. The key aspect of the successful introduction of the audit is a granting of presences to the economic entities having compliance certificates as a result of voluntary sanitary-epidemiological audit. The authorities for the accreditation and monitoring of the audit firms in the field of sanitary and epidemiological safety can be given to a federal executive body competent in this field.

Key words: *sanitary and epidemiological audit, state system for control, risk-based supervision, sanitary safety.*

The vector set by the highest state authorities to cut-down unnecessary administrative barriers to business, to introduce risk-oriented model of control and surveillance presupposes an overall reduction in scheduled inspections by supervisory authorities of legal entities and individual entrepreneurs, including those whose activities are subject to regulation by sanitary legislation [13,15]. At the same time, tasks of improving habitat safety and preserving national health are still top-relevant [2, 10]. In addition, civilian popula-

Irina V. May – PhD, DSc, Deputy Director for Research (e-mail: may@fcrisk.ru; tel.: +7(342) 237-25-47).

Ella V. Sedusova – researcher of the laboratory of complex and sanitation analysis and expertise (e-mail: makella@fcrisk.ru; tel.: +7 (342) 237-18-04).

Tatyana M. Lebedeva – PhD, DSc of the Department of Public Health and Healthcare (e-mail: rector@psma.ru; tel.: +7(342) 217-20-20).

tion and public organizations activities in protection of citizens' rights to safe environment and health have advanced significantly over the recent years. The requirements of foreign economic partners to prove safety of activities, goods and services and law abidance of domestic economic entities are constantly rising.

The Russian Federation entry into the World Trade Organization requires from state authorities an adoption of legislative and other regulatory legal acts aimed at implementing Agreements on the World Trade Organization (WTO), as well as at ensuring training of the Russian entrepreneurs for operating in WTO environment. Special challenges are in improving quality and safety of consumer products made in Russia and imported from abroad [4].

All of this requires new forms of interaction between supervisory bodies, legal entities, individual entrepreneurs, and population as consumers of goods, products, services. Among such forms, sanitary and epidemiological audit can and should act as an independent objective third authorities assessment of legal entities and individual entrepreneurs' compliance with the requirements of sanitary rules and other normative documents in the field of sanitary and epidemiological well-being in implementing their economic or other activities [1, 7]. Sanitary and epidemiological audit can be associated with a certification system for compliance with sanitary requirements and assume documentary confirmation of such compliance by authorized persons. Within the framework of a risk-oriented model of control and surveillance activities, sanitary and epidemiological audit and certification of compliance with mandatory hygienic requirements could make an alternative to scheduled surveillance measures on sites classified as of low and moderate risk of harm to human health and values under protection [11 ,12].

To date, in Russia, sanitary-epidemiological audit and voluntary confirmation of operations, works and services compliance with hygienic requirements do not have a reliable legal support. The notion of "audit" and "voluntary certification for compliance with mandatory sanitary requirements" is not given in the federal law of 12.03.1999, No. 52-FZ "On Sanitary and Epidemiological Well-Being". At the same time, for instance, the law of the Republic of Belarus dated January 7, 2012, No. 340-3, "On Sanitary and Epidemiological Well-being of the Population" defines sanitary and epidemiological audit, and establishes that the audit is conducted voluntarily, at the expense of the organizations' own funds and in the order set forth by the Council of Ministers of the Republic of Belarus. The Decree of the Ministry of Health of Belarus on 16.07.2012 No. 99 approved The Regulations on the procedure for sanitary and epidemiological audit. This document establishes that the main objective of an audit is *"... to identify ways and means of reducing the risk of adverse effects of economic or other activities on population life and health through an independent compliance assessment by organizations .... as required by legislation in the field of sanitary and epidemiological welfare of the population and providing recommendations on improving their activities ... "*

Sanitary and epidemiological audit is foreseen also by an Article 62-1 of the Code of the Republic of Kazakhstan *"On People Health and Healthcare System"*[1]. The document stipulates that *"the results of sanitary and epidemiological audit influence the determination of risk profile for epidemically significant objects under state*

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[1] On People Health and Healthcare System: The Code of the Republic of Kazakhstan No. 193-IV of September, 18, 2009 (as amended on 21.04.2016 г.) Available at: http://www.wipo.int/wipolex/ru/details.jsp?id=16058 (18.08.2016)

[2] Rules for sanitary-epidemiological audit. Approved by the Order of the Minister of National Economy of the Republic of Kazakhstan No. 216 of 17.03. 2015. Available at: https://tengrinews.kz/zakon/pravitelstvo_respubliki_kazahstan_premer_ministr_rk/zdravoohranenie/id-V1500010846/ (18.08.2016)

[3] Data as of October, 1, 2016.

sanitary and epidemiological surveillance ... and positive results of sanitary and epidemiological audit are the basis for epidemically significant objects' exemption from inspections done under a special procedure". The rules for conducting sanitary and epidemiological audit have been approved[2]. Thus, the auditors entitled to work in Kazakhstan are included in the state-register and are to submit annually the reports on sanitary and epidemiological audit to the body authorized in sanitary and epidemiological wellbeing. The form of such a report is unified and approved. However, the law provides for a number of restrictions aimed at eliminating any affiliation of the auditors to the object of audit and improving credibility of the obtained results. A list of legal entities, passed the audit procedure and got a report on compliance with mandatory requirements, is posted on the government website http://kzpp.gov.ru. Among 1067 legal entities and individual entrepreneurs audited[3] are preschool institutions, public catering facilities (cafes, canteens), swimming pools, SPA-salons, dental offices and other objects, the audit reports thereon can be used to form plans for control and surveillance activities. This list reviewed by consumers gives an opportunity to choose the most reliable services providers. In this case, the register publishes data on each auditor who signs an audit report for a specific object. This, of course, increases the auditor's responsibility, on the one hand, and is a quality guarantee of the audit performed in favor of goods and services consumers.

In accordance with the Republic legislation, audit firms and auditors personally are liable for the breach of auditing rules, and the results of sanitary and epidemiological audit can be recognized as invalid in cases, if the established audit procedure was violated or the results thereof were falsified in the audit report preparation. Disputes arising as a result of sanitary and epidemiological audit are resolved through legal proceedings. It should be noted that the audit report conclusion may be the basis for exemption from special procedure for inspections in the Republic of Kazakhstan[4].

A sound legal basis for auditing has been established in the US and EU countries [3, 8]. At the same time, audit covers a wide range of areas of economy – from accounting to medical and preventive activities. The forms of the audit organization have been elaborated in detail, the methodological materials system for auditing has been developed, published and is constantly updated. It should be noted that abroad the credibility of voluntary audit and compliance certification is quite high. In developed countries, there are tens of thousands of audit firms (only in the United States there are more than 45,000 of them. While audit firms in the United States and Great Britain are highly independent in preparation, qualification of results, in the control over how honest auditors perform their duties, in Europe countries, auditing activities are much more strictly controlled by state through a system of normative legal acts [8].

It should be noted that abroad credibility of voluntary audit and compliance certification is quite high [17]. Many large, internationally recognized firms (such as Food Safety Sanitation, SGS, Food Safety and Inspection Service, etc.) carry out auditing and implement voluntary assessment procedures for compliance with national, European and international re-

[4]Procedure for risk assessment system' formation by the state agencies (with the exception of the National Bank of the Republic of Kazakhstan). Approved by the Order of the Vice-Minister of National Economy of the Republic of Kazakhstan No.343 of April, 17, 2015

[5]Audit *Konsaltingovyi tsentr «SIVEKS»*. Available at: http://rospotreb.com/audit/ (20.09.2016)

[6] Audit sanitarnogo sostoyaniya pomozhet podgotovit'sya k vneplanovym proverkam Rospotrebnadzora. *SERKONS.* Available at: http://www.serconsrus.ru/press_centr/intervyu_s_klientami/audit_sanitarnogo_sostoyaniya_pomozhet_podgotovitsya_k_vneplanovym_proverkam_rospotrebnadzora/ (22.09.2016)

[7]SES AUDIT. *Rosproizvoditel': spravochno-informatsionnaya sistema.* Available at: http://rosproizvoditel.ru/company/4943-ses-audit (22.09.2016)

[8]Sanitarnyi audit. *SANPIN-HELP.RU.* Available at: https://sanpin-help.ru/sanitarnyj-audit/ (22.09.2016)

[9] Sanitarnyi audit i konsalting Available at: http://sanering.ru/company/ (25.09.2016)

quirements, including such demanding, as ISO 22000:2005 standards "Food Security Management Systems. Requirements for any organization in the food chain", ISO 22006:2009" Quality Management Systems. Guidelines for the Application of ISO 9001:2008 to Crop Production, FAO Food and Nutrition Paper 63 "Street Foods", etc. [16, 20, 21]. For all auditors in the West, compliance with GAAS standards (audit standards) is mandatory. Interstate audits are in place with mandatory data publication [18, 19]. Compliance with auditing rules (standards) is verified through such analytical procedure, as reviewing internal and external audit documentation. It is namely the preparation of auditor's working papers, with the details of audit planning, its progress, accounting and control system analysis, findings obtained from specific sections of an audit, indicates that the audit was in fact performed and the data – not falsified [14].

Nowadays, food safety audit is the most demanded in assessing the objects under surveillance for compliance with sanitary and epidemiological requirements [16, 20, 23]. Such types of audit, as audit-inspection (one-time audit before entering a new project or partnership), audit in monitoring mode (as a means of systematic self-control), or a targeted problem-oriented audit (when there is a problem and there is a need to identify the causes and sources of the given problem) [22].

In the Russian Federation a number of organizations offer and provide services on sanitary and epidemiological audit (for instance, SIVEX Consulting Center in Moscow[5], "Sercons" LLC[6], registered in Moscow and having branches in Yekaterinburg, Samara, Kazan and other cities, CSC "SAS-Audit", Moscow[7], "SANPIN-HELP", Moscow[8], "Sanering" LLC, Moscow[9] and etc.). As there is no accreditation system for sanitary audit in Russia, auditors register is absent, no procedures and forms of audit data reporting in place, it does not seem possible to assess service quality, or adequacy of its cost. As a rule, today's sanitation audit is performed immediately before the planned measures of state control. The main objective is to avoid administrative penalties in the form of fines, orders to suspend operations and other sanctions. Undoubtedly, audit results eliminate the revealed inconsistencies with sanitary requirements. However, in a number of cases, such inconsistencies are being masked or competently circumvented during an inspection period. The main purpose of an audit is a real reduction in risks of causing harm to population health, improving safety of environment, formation of social responsibility of an economic entity pale into insignificance.

At the same time, it is obvious that audit, as a procedure for self-monitoring, professional assessment, "onlooking ", is in demand by business entities. However, the main obstacle to the fully-realized and efficient use of sanitary audit is the lack of regulatory framework and incentives established in legislation[10] to conduct sanitary audit for enterprises, organizations, individual entrepreneurs.

However, the practice for legislative consolidation of audit as an instrument of public administration in Russia is available. Thus, Federal Law No. 307-FZ dated 30.12.2008 "On Auditing" and Resolution of the Russian Federation Government No. 696 of September 23, 2002 "On Approval of Federal Auditing Rules (Standards)" regulate financial (accounting) audit. Audit activities are carried out by audit firms and individual auditors who are members of one of the self-regulatory organizations of auditors. Self-regulating organizations conduct certification of auditors, monitor quality of audit firms operation, individual auditors work with respect to their members, and maintain a register of audit firms and auditors. The authorized federal body (the

[10]*Federal Law ddt. August, 8, 200. No. 126-FZ "On licensing of certain types of activities"* Available at: http://www.consultant.ru/cons/cgi/online.cgi?req=doc; base=LAW;n=191768#0 (25.09.2016).

RF Ministry of Finance) introduces data on self-regulating auditor organizations into the state register of SROs and effects government control (surveillance).

The relevant laws of the Russian Federation include fire safety audit, tax and environmental audit [5, 6, 7]. So, for example, the legal basis for environmental auditing is formed by Federal Law No. 7-FZ of January 10, 2002 "On Environmental Protection", which provides for an "environmental audit" as an independent, comprehensive documented assessment of an entity's economic and other activities compliance with the requirements, including of standards and normative documents ... requirements of international standards and preparation of recommendations for improving such activities ". In the development of federal approaches to environmental auditing, the Law of St. Petersburg of December 26, 2005 No.712-109 "On Urban Environmental Control in St. Petersburg and Administrative Responsibility for Violations in Environmental Protection", determines objects of urban environmental control not subject to scheduled inspection:

– that have implemented and supported environmental control system (environmental management system) at the enterprise and submitted relevant documents to the executive body of state power in St. Petersburg that implements urban environmental control;

– once in two years submitting a positive conclusion of environmental audit in the executive body of state power in St. Petersburg, which implements urban environmental control.

Similar approaches can be used also at arranging sanitary and epidemiological audit. So, for example, audits conclusions can be taken into account by Rospotrebnadzor when performing control and surveillance functions. Authorized bodies of state power may not conduct scheduled inspections of those objects of economic and other activities that will submit the conclusions of sanitary audit that the requirements of sanitary legislation, regulatory documents are fully complied with, and hygienic standards are observed at these objects. At the same time, state inspectors will be able to selectively check the objects under control. If violations in contradiction with the sanitary audit conclusion are revealed, then the established order of selective state sanitary surveillance is being canceled, and application is introduced to annul certification of the auditors who performed sanitary audit at the given facility.

In general, introducing the procedure for sanitary audit and voluntary compliance assessment can reduce the number and frequency of inspections on sites that, being socially responsible, bear the burden of voluntary audit, are open and transparent to civil society and supervising authorities and ensure that their products and services are in conformity with the established requirements and standards. According to a number of researchers, a competent, modern, and having unique information resources audit institution is able to perform both regulatory and constructive functions, ensuring the selection of promising directions for the development of the country.

At the same time, it is obvious that state participation in ensuring proper quality of auditing is mandatory. According to the Russian legislation in licensing , this procedure is subjected to the types of activities, the implementation of which may entail damaging rights, legitimate interests, health of citizens, etc. It seems that low professional or deliberately biased auditing in ensuring sanitary and epidemiological welfare of the population can create prerequisites for damage to protected values, including health of citizens, since an appropriate management decisions are taken (or not taken) based on audit findings. In this regard, it seems rational to legislatively consolidate the licensing procedure for auditing organizations or individual auditors. This statement is also expressed by specialists in other areas of audit [7, 12].

At the same time, sanitary and epidemiological audit does not violate property rights and promotes market economy development,

decreases administrative pressure on business by reducing surveillance activities in the field of sanitary and epidemiological well-being. Moreover, developing and implementing risk-oriented model of control and surveillance at the national level is also most responsive to audit objectives on identifying and eliminating the most problematic "bottlenecks" in the managed sphere [22].

It should be noted that qualified auditors are in demand always and everywhere, and the demand for this profession increases every year. And the main task of audit services currently is not only to monitor compliance with legislation that regulates various aspects of enterprises operations, but also to systematically eliminate and prevent downsides in this activity.

In general, to introduce sanitary-epidemiological audit in habitat and population health quality management system in the Russian Federation, it is necessary to:

- establish sanitary and epidemiological audit as a form of assessing the compliance of activities and assets used with the legislation requirements at a statutory level;

- create national system that regulates emergence and registration of organizations with the right to auditing in the field of hygiene security. Authorities for accreditation of audit organizations in hygiene security may be given to a federal executive body competent in this activity;

- establish the procedure for accreditation (registration, recording) of audit services in the field of ensuring sanitary and epidemiological welfare of the population with definition of qualification requirements for auditors and technical experts; to establish a body for certification in hygienic safety.

- develop rules for conducting sanitary and epidemiological audit and forms of data presentation thereof;

- develop Regulations on auditors' registers in the field of sanitary and epidemiological welfare of the population and conducted audits of legal entities and individual entrepreneurs;

- create a system for the special training of auditors who, in particular, have the methodology for assessing the risks of harm to health and other socially significant values protected by Rospotrebnadzor;

- determine place, role of sanitary and epidemiological audit in public administration system for population sanitary and epidemiological welfare and its relation to the risk-oriented control and surveillance activities of Rospotrebnadzor;

- establish at statutory level preferences for economic entities that have certificates of compliance based on voluntary audit results;

- arrange for monitoring and annual analysis of auditing results.

The system of sanitary and epidemiological audit in the country can be developed as one of the activities in the market of sanitary-epidemiological operations and services subject to licensing (accreditation).

A separate direction of audit as an instrument of the population sanitary-epidemiological welfare may be a sanitary-epidemiological audit of a territory, city, municipalities (county, district).

In general, introducing sanitary audits into practice, as well as using its results for inspections, will be an important step towards improving the quality of services and works performed, upgrading efficiency of control and surveillance activities and safety of the Russian Federation citizens

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