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HYGIENIC CHARACTERISTICS OF THE PRIORITY ENVIRONMENTAL MEDIA AND RISK ASSESSMENT OF THEIR INFLUENCE: A CASE STUDY IN MOSCOW CITY

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A comparison of the pollution levels in Moscow and Russia revealed the priority pollutants in the outdoor air and water from the centralized drinking water supply. A hygienic study of population in Moscow was conducted to assess the health risks associated with the chemical pollution of the ambient air and water from the systems of the centralized drinking water supply. The hygienic analysis of the environmental pollution and a health risk assessment of the Moscow population revealed that the priority risk factors affecting the population include: benzene, nitrogen dioxide, weighed substances, formaldehyde, nitrogen oxide, ozone – for ambient air, and also arsenic and chrome (IV) – for water from the systems of the centralized drinking water supply.

Key words: *hygienic characteristic, health risk assessment, priority pollutants, megalopolis inhabitants.*

Introduction. The quality of air and drinking water in large cities (metropolises) presents a major health risk to the residents [1[. The air in a metropolis like Moscow suffers from a large amount of emissions with various toxicological characteristics. Motor vehicles are yet another hazardous factor that creates health risks in large cities [2, 3, 11, 13, 14]. The drinking water consumed by such a large population comes from underground and surface sources and does not always meet the hygienic requirements. For this reason, household and drinking water treatment and decontamination is needed, but it is also associated with health risks.

In this regard, it is practical to analyze the negative health effects associated with the air and drinking water pollution in Moscow and detect the most hazardous health risk factors.

The purpose of the research is to give a hygienic characteristic to the state of the environment and assess its potential impact on public health in the city of Moscow.

Tasks:

1. Determine the biggest air and household/drinking water pollutants in Moscow based on the comparison of pollution indicators in Moscow and at the nation-wide level;
2. Conduct a hygienic health assessment study to analyze the outdoor air and household/drinking water chemical pollution;
3. Reveal the biggest health factors based on the results of a health assessment study in Moscow;

Materials and Methods.

In the comparative hygienic study of the air and household/drinking water quality in Moscow and at the nation-wide level in 2011-2014, the following data was used: a State Report "About the quality of the sanitary and epidemiological wellbeing in the Russian Federation", and the State Report (About the sanitary-and-epidemiological wellbeing in Moscow (reports for 2012, 2013, and 2014) [4, 5, 6, 7, 8, 9]. Other health risk factors (chemical contaminants in the outdoor air and

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water) were verified based on a socio-hygienic screening study.

The assessment of the health risks associated with the impact of polluted air and household/drinking water was performed following the guidelines in the "Guide to Public Health Assessment of Environmental Pollution" R 2.1.10.1920-04 [12]. The research aimed to determine the causal relationship between the hazardous substances and health effects. The following effects were determined during the assessment of the real harm of hazardous effects created by inhalation and peroral chemical exposure: carcinogenic and acute and chronic noncancer effects. The level of non-cancer risk was determined by way of comparing the factual levels of chemical exposure with the safe exposure levels. The hazard quotients (HZ) were calculated for acute and chronic exposure. In the assessment of the combined health effects associated with the chemical contaminants in the outdoor air and water, the hazard indices (HI) were calculated accounting for the critical organs (systems) affected by the analyzed substances. In the assessment of the chemical pollutants in the Moscow air, the data from the field studies of outdoor air obtained at the Moscow monitoring stations for 2011-2013. The health risk assessment in Moscow was performed with the use of the data about the average annual concentrations of substances in the household/drinking water in Moscow for 2011-2013.

Information about the average annual chemical concentrations in the outdoor air and household/drinking water in the Moscow administrative districts was summarized in a single dataarray. The coordinates of the monitoring stations and quotient values were laid down upon an electronic map of Moscow followed by the data interpolation and extrapolation.

To analyze the dissemination of the average annual concentrations of chemical contaminants in the outdoor air, approximation tests (inter- and extrapolation) were conducted at the monitoring stations in all the city districts. For this purpose, control points were mapped on the electronic city map in the form of a regular grid with the area of 3240 km2, 54km by 60 km, with the spacing of the grid nodes of 200x200m. Based on data approximation, the average values for each of the administrative districts were calculated.

Results

A comparative analysis of the contaminant levels in the Moscow air and the other of some large cities across the globe including Paris, London, Stockholm, and Berlin as of 2012 shows that the level of air pollution in Moscow is compatible to the level of air pollution in other cities [10]. The average annual concentrations of pollutants in all the analyzed cities are characterized by a high level of special variability. The maximal level of air pollution in Moscow as well as in the other large cities is registered in the areas adjacent to major highways.

According to the report by the Federal Service for the Protection over Consumer Rights and Human Wellbeing [4, 5, 6], the level of air pollution in the Russian Federation decreased over the period of 2011-2014. In 2011, the fraction of the outdoor air samples with exceeding MAC totaled 1.5%, and in 2014 the figure went down to 1.1%.

According to the socio-hygienic monitoring results described below, the Moscow air pollution is lower as compared to the nation-wide level: the specific share of nonstandard air samples in 2014 was at the 2011 level at 0.22%. In 2012, the fraction of the air samples with exceeding MAC increased to 0.42% (Figure 1).

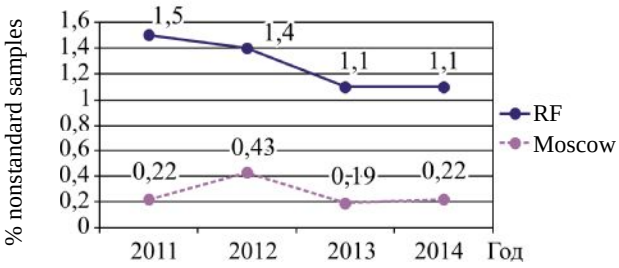

Figure1 The level of air pollution in Moscow and in the country in general, %

The biggest air pollutants are motor vehicle. Because of that, the hygienic standards are always exceeded in the close proximity to major highways both in Moscow and in the country in general. For example, in 2011, the fraction of nonstandard air samples collected at the RF highways near the residential areas totaled 2.5%, and near the industrial plant areas – 0.98%. In 2011, in Moscow, 1.37% of nonstandard air samples were registered near highways in the residential areas, and 0.1% of nonstandard samples were registered in the industrial areas. Recently, the air quality has decreased in the areas of highway emissions in Moscow. In 2012, the fraction of nonstandard air samples totaled 0.42$, and in 2013 it totaled 0.06%. in 2014, no samples exceeded the hygienic

standards. Similar trends are typical of the Russian Federation at large: in 2014, the fraction of unsatisfactory air samples went down by 0.97% as compared to 2011.

The levels of the following pollutants exceed the hygienic standards in Russia: suspended solids (up 3.10%), sulfur dioxide (up 0.62%), digidrosulfid to 1.83%), carbon monoxide (up to 1, 97%), nitrogen dioxide (0.95%), nitrogen oxide (0.52%), ammonia (0.85%), phenol (to 2.32%), formaldehyde (2.02%) sulfuric acid (0.55%), benzo (a) pyrene (to 2.71%), fluorine compounds (fluorine based) (to 1.27%), hydrogen fluoride (up to 1.46%), chlorine compounds (to 1.22%), hydrogen chloride (do1,45%), hydrocarbons (to 0.86%), benzene (to 0.46%), toluene (to 0.34%), xylene (to 1.11%), aliphatic saturated hydrocarbons (to 1.24%), aliphatic unsaturated hydrocarbons (to 1.24%), lead (to 0.80%), cadmium (to 0.41%), manganese (up 0.44%) (Table. 1).

For some substances, the MAC excess is growing in the outdoor air (2011-2014): phenol, and fluorine compounds, benzene, toluene, and manganese. For substances such as hydrogen sulfide (digidrosulfid), formaldehyde, benzo(a)pyrene, hydrogen fluoride, hydrocarbons, it can be noted that the fraction of nonstandard samples was growing from 2011 to 2013; in 2014 it decreased, and the growth rate was negative in 2011 g (Table. 1)

The violation of hygienic standards was registered in Moscow in 2011-2014 in terms of the level of suspended solids, digidrosulfid, carbon monoxide, nitrogen dioxide, nitrous oxide, ammonia, phenol, formaldehyde, chlorine and its compounds, hydrogen chloride, hydrocarbons, aliphatic hydrocarbons marginal (tab. 1).

The fraction of MAC in the outdoor level increased for hydrogen sulfide, carbon monoxide, nitrogen dioxide, ammonia, benzo(a)pyrene (Table 1).

Table 1

The fraction of air samples with exceeding MAC in terms of individual contaminants in the RF cities and in Moscow, %

Substance	Russia					Moscow				
	2011	2012	2013	2014	Growth rate	2011	2012	2013	2014	Growth rate
suspended solids	3,10	2,48	2,03	1,91	–38,4	0,31	0,23	0,13	0,06	–80,6
sulfur dioxide	0,53	0,62	0,41	0,42	–20,8	0,00	0,09	0,00	0,00	–
digidrosulfid	1,64	1,73	1,83	0,97	–40,9	0,45	2,55	0,89	0,60	33,3
Carbon monoxide	1,97	1,59	1,32	1,15	–41,6	0,09	0,52	0,15	0,13	44,4
Nitrogen dioxide	0,95	0,93	0,71	0,82	–13,7	0,03	0,64	0,10	0,59	1866,7
nitric oxide	0,52	0,39	0,41	0,35	–32,7	7,03	0,00	0,00	0,00	–100,0
Ammonia	0,84	0,85	0,66	0,41	–51,2	0,00	0,85	1,17	0,30	100,0
Phenol	2,10	1,70	2,19	2,32	10,5	0,09	0,00	0,07	0,02	–77,8
formaldehyde	1,98	1,83	2,02	1,69	–14,6	0,07	0,38	0,34	0,00	–100,0
sulfuric acid	0,08	0,13	0,55	0,11	37,5	0,00	0,00	0,006	0,00	–
benzo (a) pyrene	1,82	1,96	2,71	1,43	–21,4	0,00	0,00	0,00	0,22	100,0
Fluorine and its compounds (calculated as fluorine)	0,72	1,27	1,46	1,30	80,6	0,00	0,00	0,00	0,00	–
hydrogen fluoride	0,83	1,46	1,30	0,74	–10,8	0,00	0,00	0,00	0,00	–
chlorine and its compounds	1,22	0,64	0,79	0,70	–42,6	0,48	0,90	0,21	0,00	–100,0
hydrogen chloride	1,45	0,73	0,93	0,92	–36,6	0,84	0,92	0,21	0,00	–100,0
hydrocarbons	0,76	0,89	0,38	0,41	–46,1	0,36	0,21	0,06	0,13	–63,9
Benzene	0,26	0,46	0,15	0,33	26,9	0,02	0,05	0,00	0,00	–100,0
Toluene	0,30	0,33	0,15	0,34	13,3	0,00	0,00	0,00	0,00	–
xylol	1,07	1,11	0,44	0,72	–32,7	0,00	0,00	0,00	0,00	–
aliphatic limit	1,09	1,23	0,44	0,27	–75,2	0,62	0,38	0,07	0,25	–59,7
aliphatic unsaturated	1,24	0,85	1,08	0,13	–89,5	0,00	0,00	0,00	0,00	–
Lead	0,80	0,37	0,28	0,39	–51,2	0,00	0,00	0,00	0,00	–
Cadmium	0,04	0,41	0,00	0,00	–100	0,00	1,37	0,00	0,00	–
manganese	0,08	0,44	0,00	0,35	337,5	0,00	4 из 39	0,00	0,00	–

Overall, the frequency of exceeding the maximal single maximal allowable concentrations of the chemical in the Moscow air is lower as compared to the country as a whole. The dynamic patter for the fraction of nonstandard air samples corresponds with the average Russian, however there are some differences concerning individual pollutants. For example, the leading chemical contaminants in the Russian air for which the nonstandard samples are increasing include hydroxybenzene and its derivatives, and fluorine compounds, benzene, toluene, and manganese. In Moscow, those priority pollutants are hydrogen sulfide, carbon. This lists needs to be verified and, possibly, expanded based on the monitoring and risk assessment results.

In addition to atmospheric contaminants, public health can be also impacted by the chemicals in drinking water.

The household and drinking water system in Moscow feeds from the surface water sources characterized by the presence of hazardous agents that evolve from water decontamination, as well as from underground sources characterized by the presence of metals.

In 2014, 99.6% of the Moscow population was provided with quality drinking water which is a slight decrease as compared to 2011 (99.98%). Overall, this figure for Russia as a whole totals only 63.9% but the fraction of the population with access to quality drinking water in the country has gone up by 3.7% as compared to 2011.

In 2014, the number of water supply sources went up sharply to 65.8% in Moscow (in 2013 this indicator was at 19.7%). This could have been related to the accession of the new territories [9]. The fraction of water supply sources which do not meet the sanitary and epidemiological requirements in Moscow is higher than across the board in the country. For example, this indicator reached 15.8% in Russia from 2012 to 2014.

The main surface water sources in Moscow in 2011-2014 did not meet the hygienic requirements (Table 2).

The low quality of water supply sources in Moscow explains the fraction of unsatisfactory surface water samples in terms of sanitary and chemical indicators: 84,7 % (in 2014) which grew by 29,2% since 2011. However, there has been a positive change: since 2013: the fraction of the water samples that do not meet the hygienic standards has decreased by 11.1%, though it is still at a high level. The growth rate of unsatisfactory water samples collected from underground water sources in Moscow is negative (from 59.4% samples in 2011 to 49,2 % samples in 2014).

Table 2

The water Sources that Do Not Meet the Sanitary and Epidemiological Requirements, %

Area	Source	2011	2012	2013	2014
Russia	Surface	35,7	34,9	35,0	35,2
	Underground	15,8	15,4	15,4	15,3
	Total Sources	16,2	15,8	15,8	15,7
Moscow	Surface	100	100	100	100
	Underground	32,5	16,5	14,1	64,9
	Total Sources	40,8	21,9	19,7	65,8

Table 3

The Specific Weight of the Moscow and Nation-Wide Water Samples that Do Not Meet the Sanitary Requirements in Terms of Sanitary and Chemical Indicators, %

Area	Source	2011	2012	2013	2014
Russia	Surface	21,2	22,2	22,7	22,8
	Underground	30,7	29,4	29,7	27,9
Moscow	Surface	55,5	52,8	95,8	84,7
	Underground	59,4	58,2	48,4	49,2

Although the fraction of unsatisfactory water samples from the central water system is rather high, there has been an improvement in the quality of drinking water in the distribution system, especially in Moscow.

In Moscow, the fraction of samples that do not meet the hygienic requirement from the central water distribution system totaled 2.4% (2014) – a 1.1% decrease as compared to 2011. This indicator is at a higher level in Russia in general: at 15,5% (2014), even though there has been a tendency to its decrease since 2011 by 1,4 %.

The quality of drinking water in the central water supply system in terms of sanitary and chemical indicators in Russia in 2011-2014 was described by the presence of the following chemical substances: iron (15.1% of non-standard samples in 2014), silicon (20.5% in 2014), manganese (7.1% in 2014), aluminum (2.4% in 2014), ammonia (1 7% in 2014 g), chloroform

(11.3% in 2014), boron (8.6% in 2014), chlorides (8.6% in 2014), sodium (13.9% in 2014).

In Moscow, the quality of drinking water in the central water supply system in terms of sanitary and chemical indicators has been impacted by the content of iron за (1,9 % nonstandard samples in 2013 and 2,2% - in 2014).

Consequently, the fraction of unsatisfactory samples collected from the Moscow central water distribution system is lower as compared to the national level: 2,4 % and 15,5 % respectively (2014). In Russia, the leading chemical substances in the water from the central household/drinking water supply system against which the hygienic standards are violated include iron, silicon, manganese, aluminum, ammonia, boron, sodium, chloride and chloroform. To compare, in Moscow the bulk of unsatisfactory water samples in terms of sanitary and chemical indicators is explained by the presence of the iron.

In the course of the hygienic analysis of the outdoor air and household/drinking water in Moscow, the biggest pollutants were selected which have shown a growth in nonstandard samples: for outdoor air, for air - it is hydrogen sulphide, carbon monoxide, nitrogen dioxide, ammonia, benzo(a)pyrene, and in the water of the centralized drinking water supply, the priority substance is iron.

Since public health can be impacted by the substances the level of which in the air and water does not exceed the hygienic standards, it is possible to expand this list of major pollutants in Moscow by assessing the level of public risk.

At the hazard identification stage, the following chemicals were selected as major air pollutants in Moscow: nitrogen (II) oxide (nitric oxide), nitrogen (IV) oxide (nitrogen dioxide), ammonia, benzene, suspended solids, bromodichloromethane, hydroxybenzene (phenol), dimethylbenzene (xylene) methylbenzene (toluene) digidrosulfid (hydrogen sulfide), ozone , propan2-one (acetone), sulfur dioxide (sulfurous anhydride), carbon monoxide, formaldehyde, lead and its compounds. Among these chemicals, only bromodichloromethane, formaldehyde, benzene and lead have a carcinogenic effect.

The exposure assessment results are presented in Table 4.

Table 4

Maximal and average annual concentrations of chemicals in the Moscow outdoor air by district in 2011-2013 (mg/m^3)

Chemical	Average annual concentrations	MAC av daily, mg/m^3	District	Maximal Single Concentration	MAC mxsingle, mg/m^3	District
Carbon monoxide	Up to 2,028	3,0	Eastern AD	Up **19,3**	5,0	SE AD
Propan-2-one (acetone)	Up to 0,099	–	Southwestern AD	Up 0,050	0,35	N AD
Digidrosulfid (Hydrogen Sulfide)	Up to 0,003	–	Southeastern AD	Up 0,006	0,008	SE AD
Lead and its inorganic compounds	Up to 0,0001	0,0003	Southern AD	-	0,001	-
bromodichloromethane	Up to 0,001	–	Zelenograd AD, Northwestern AD	-	–	-
Sulfur dioxide (sulfurous anhydride)	Up to 0,044	0,05	Southern AD	Up 0,470	0,5	SE AD
Nitrogen (II) oxide (nitrogen oxide)	Up to 0,067	0,06	Southern AD	-	0,4	-
Xylene (Xylene)	Up to 0,032	–	Central AD	до 0,050	0,2	S AD
Methylbenzene (toluene)	Up to 0,060	–	Central AD	Up 0,150	0,6	S AD
Ozone	Up to 0,049	0,03	Zelenograd AD	-	0,16	-
Hydroxybenzene (phenol)	Up to 0,004	0,01	Zelenograd AD	Up 0,055	0,003	SE AD
Benzene	Up 0,024	0,1	Northeastern AD	Up 0,226	0,3	SE AD
Ammonia	Up 0,069	0,04	Zelenograd AD	Up 0,080	0,2	S AD
Nitrogen dioxide (Nitrogen (IV) oxide)	Up 0,068	0,04	Northern AD	Up 0,800	0,2	E AD
suspended solids	Up 0,199	0,15	Western AD	Up 1,200	0,5	E AD
Formaldehyde	Up 0,015	0,003	Central AD	Up 0,108	0,035	C AD

Increased levels of chemical substances in the Moscow air in 2011-2013 were registered for nitrogen dioxide, nitrogen oxide, ozone, ammonia, suspended substance, formaldehyde (for average per annum concentrations) as well as carbon monoxide, hydroxybenzene, nitrogen dioxide, suspended solids, formaldehyde (for maximal concentrations). Exceeding hygienic standards in terms of hazardous substances in the air were registered in the Southern, Zelenograd, Western, Central, Eastern and South-Eastern Administrative Districts.

In Moscow, in 2011 – 2013, unacceptable levels of individual cancer risks associated with benzene exposure (from 4,09h10-6 1,82h10-4 up in 2013) and formaldehyde (from 5,33h10-5 in 2012 to 1,91h10-4 in 2013) were detected. Total individual carcinogenic risk for Moscow went up from $7{,}49x10^{-5}$ in 2012 to $7{,}77x10^{-4}$ that corresponds to the third range of the risk level that is unacceptable to the population as a whole (Figure 2). The presence of such risk requires the development and implementation of health activities. Formaldehyde is the biggest pollutants contributing to the total carcinogenic risk.

In 2011-2013, the priority substances contributing to the acute non-cancer health risks were benzene (HQ to 1.5 in 2012), nitrogen dioxide (HQ to 1.7 in 2013), suspended solids (HQ to 4 in 2012 g), and formaldehyde (HQ and 2.25 g 2013). At that time, unacceptable levels of acute non-cancer risks were registered in Moscow for the respiratory system (HI to 6.06 in 2012), vision (HI to 2.25 in 2013), immune and reproductive systems (HI 1, 51 in 2012), development processes (HI to 2.35 in 2012) and systemic exposure (HI to 4.00 in 2012).

Acute non-cancer risk that affects the respiratory system is formed by the combined effects of suspended matter (deposit 58%), sulfur dioxide (15.3%), nitrogen dioxide (11.08%), as well as phenol, xylene, toluene, hydrogen sulfide, formaldehyde, and ammonia. Acute non-carcinogenic risk is found to affect the immune and reproductive systems, and is associated with benzene exposure. Additional cases of eye disease are caused by the combined effect of ammonia (16.53%), phenol (6.61%), toluene (61.98%) and formaldehyde (14.88). Acute non-carcinogenic risk that affects the development processes is caused by the combined effects of carbon monoxide (99.48%) and benzene (0.52%). Acute non-carcinogenic risk that causes systemic effects is formed by the impact of suspended solids.

The highest level of non-cancer risk was registered in the Eastern, Zelenogra, and Southeastern Administrative Districts (Figure 3).

During the assessment of the chronic non-cancer risk, excessive values of the hazard quotients were identified for nitrogen oxide (HQ 1,12 in 2011), nitrogen dioxide (HQ to 1.69 in 2012), suspended solids (HQ to 2.65 in 2011), formaldehyde (HQ to 4.85 in 2013), and ozone (HQ to 1.62 in 2012). The highest levels of chronic non-cancer risk totaled: for the respiratory system - up to 10.64 in 2012, for the immune system and eyes - 4.85 in 2013), for the blood system - up to 3.37 in 2011, for the central nervous system - to 2.16 in 2011, to process development - to 1.51 in 2011, for the cardiovascular system - to 1.68 in 2011. The highest levels of chronic non-cancer risk were registered in the Eastern, Southern, and Southeastern Administrative District (Figure 4).

The chronic non-cancer risk affecting the respiratory organs is caused by the combined exposure to formaldehyde (41,7%), nitrogen dioxide (15,5%), ozone (14,6%), suspended solids (11%), as well as nitrogen oxide, ammonia, phenol, xylene, toluene, and sulfur dioxide. The chronic non-cancer risk affecting the immune system and vision is caused by formaldehyde. Additional cases of the circulatory blood diseases are caused by the combined exposure to nitrogen dioxide (41.6%), nitrogen oxide (33.2%), benzene (17.9%), acetone, and lead. The chronic non-cancer risk affecting the central nervous system is caused by the combined exposure to benzene (28.1%), carbon oxide (26.4%), phenol (23.5%), lead (11.1%), xylene, toluene and acetone. The chronic non-cancer risk affecting the development processes is caused by the combined exposure to benzene (40.2%), carbon monoxide (37.7%), lead (15.8%), toluene and bromodichloromethane. The chronic non-cancer risk affecting the cardiovascular system is caused by the combined exposure to benzene (36%), carbon monoxide (33.8%) and phenol (30.2%).

At the hazard identification stage, the following chemical substances found in the household/drinking water were selected during the health risk assessment study: Lead, ammonia and ammonium ion, strontium, terahlormetan, trichloromethane, barium, fluorine, chlorine, chromium (III), chromium (VI), boron, aluminum, iron, cadmium, lithium, arsenic, nickel.

The average concentrations of the chemicals in the water were calculated to assess the level of exposure (Table 5).

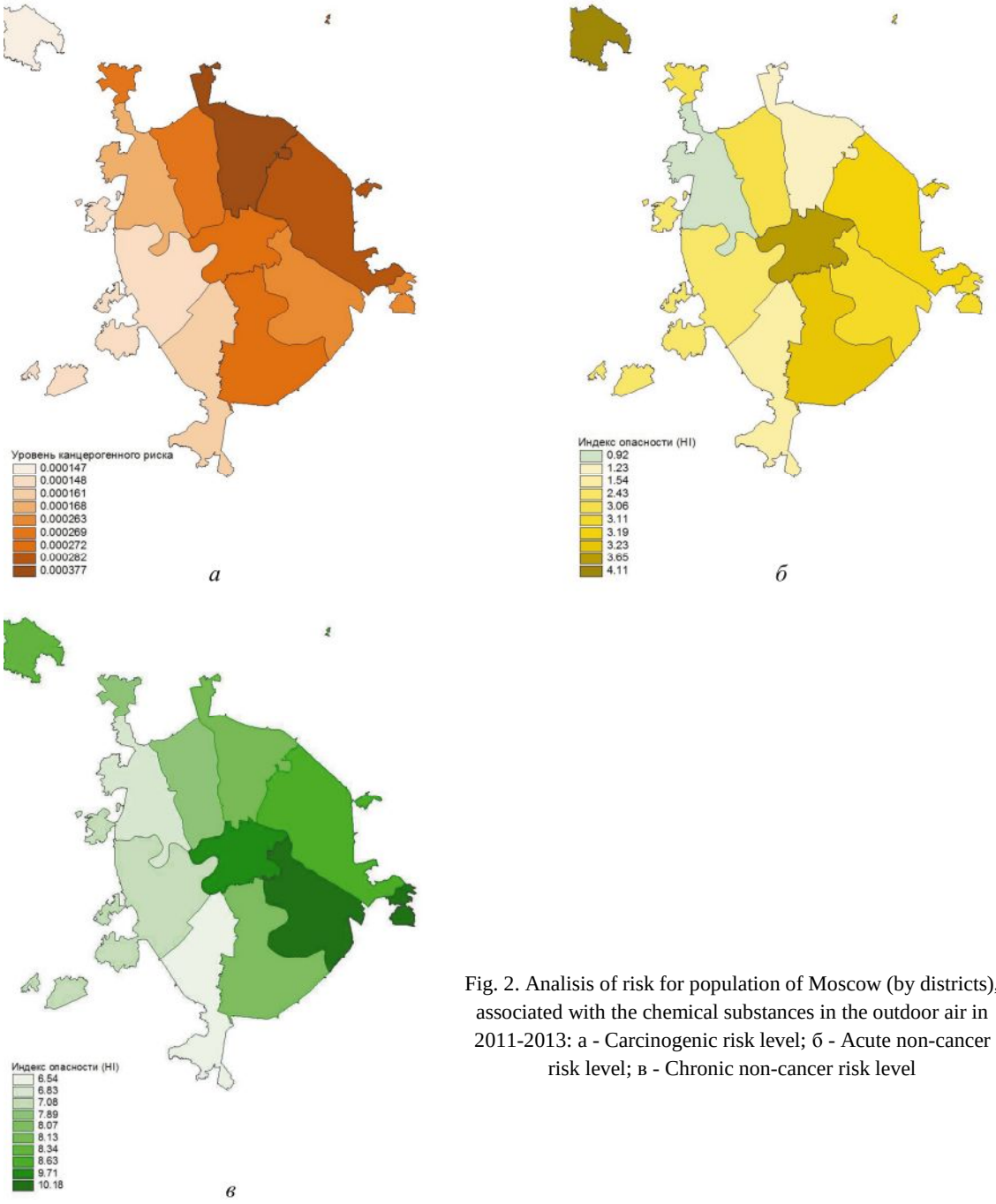

Fig. 2. Analisis of risk for population of Moscow (by districts), associated with the chemical substances in the outdoor air in 2011-2013: а - Carcinogenic risk level; б - Acute non-cancer risk level; в - Chronic non-cancer risk level

According to the socio-hygienic monitoring, excess of MAC content in the water was registered for chromium IV, arsenic and cadmium.

In 2011-2013, unacceptable levels of individual carcinogenic risk associated with arsenic (up to $1.5x10^{-4}$ in 2011) and chrome (VI) (up to $1.1x10^{-4}$ in 2013) exposure were registered in Moscow. The highest levels of total carcinogenic risk associated with the chemical substances in the centralized household/drinking water were registered in the Eastern, Zelenogra, Norther, Northeaster, and Northwestern Administrative Districts.

The assessment of chronic non-cancer risk did not reveal any increased hazard quotients for the analyzed substances. The hazard indices calculated during the assessment of the risk of chronic exposure to the hazardous substances in the centralized household/drinking water in Moscow

in 2011-2013 did not exceed the acceptable values in all the administrative districts.

Table 5

Maximal average annual concentration of the substances in the centralized household/drinking water in Moscow in 2011-2013, mg/m^3

Chemical	MAC	Average concentration per annum
Lead	0,03	Up to 0,03
Ammonia and ammonium ion	–	up to 0,01
Strontium	7	up to 0,01
Carbon tetrachloride	–	up to 0,04
Trichloromethane (chloroform)	0,2	up to 0,09
Barium	0,1	up to 0,02
Fluorine	–	up to 0,22
Chlorine	–	up to 0,22
- Residual free	In the range 0,3 - 0,5	
- Residual bound	In the range 0,8 - 1,2	
Chromium III	–	0
Chromium VI	0,05	up to 0,2
boron	0,5	up to 0,01
Aluminum	0,5	0
Iron	0,3	up to 0,02
Cadmium	0,001	up to 0,03
Lithium	–	up to 0,02
Arsenic	0,05	up to 0,78
Nickel	0,1	up to 0,02

The health risk assessment study determined that this concentration of the chemical substances in the household/drinking water did not create unacceptable chronic non-cancer risks. At the same time, unacceptable levels of individual carcinogenic risk associated with arsenic (up to $1{,}50 \times 10^{-4}$ in 2011) and chrome (VI) (up to $1{,}11 \times 10^{-4}$ in 2013) exposure were registered in the Easter, Zelenograd, and Northwestern Administrative Districts.

Conclusion. The Moscow Office of the Federal Service for Supervision over Consumer Rights Protection and Human Wellbeing reported that the biggest air pollutants in terms of the growing fraction of the samples that violated the hygienic standards were hydroxybenzene and its derivatives, and fluorine compounds, benzene, toluene, and manganese. And iron was reported as the biggest water pollutant.

The health risk assessment study aimed to analyze the impact of the air pollution in Moscow determined that the unacceptable health risk was caused by such chemical substances as benzene, nitrogen dioxide, suspended particles, formaldehyde, nitrous oxide, ozone. In that situation, the priority critical organs and systems were the respiratory organs, visual organs, the immune and reproductive systems, and the development processes. Unacceptable risk levels were registered in the Eastern, Zelenograd, Southeastern, and Southern Administrative Districts of Moscow In 2011-2013, unacceptable risk associated with the inhalation exposure to benzene (up to $1{,}82 \times 10^{-4}$) and formaldehyde (up to $1{,}91 \times 10^{-4}$). The total carcinogenic risk reached $7{,}77 \times 10^{-4}$, which is unacceptable to the population at large.

The health risk assessment determined that the chemical substances in the household/drinking water did not cause unacceptable non-cancer risks. However, in the Easter, Zelenograd, and Northwestern Administrative Districts, unacceptable levels of individual carcinogenic risk associated with arsenic and chrome (IV) exposure were found.

The leading hazard-bearing factors revealed in the course of the hygienic analysis of the air and water pollution in Moscow included: benzene, nitrogen dioxide, particulate matter, formaldehyde, nitrogen oxide, ozone - for the air, and arsenic and chromium (IV) – for the centralized household/drinking water supply system.

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