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HEALTH RISK ASSESSMENT FROM CHEMICAL AIR POLLUTION FOR THE POPULATION OF KAZAN (BASED ON THE LABORATORY RESEARCH OF DIFFERENT ADMINISTRATION DEPARTMENTS)

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Instrumental monitoring of outer air of Kazan is represented by the systems of observation of three different government agencies. There are non-permissible levels of risk from atmospheric particulate matter being formed in the city which is confirmed by three different governmental agencies. The particulates which are of the size of 10 and 2.5 μm (micrometers) are of the greatest danger because almost all the explored territories have the non-permissible levels of non-carcinogenic risks being formed from their impact. Both carcinogenic and non-carcinogenic risks caused by the impact of formaldehyde and soot are non-permissible for the health of the population. According to the data of the three agencies, there is a picture of mutual confirmation of the results. However, there are significant discrepancies in the results on separate pollutants which doesn't allow to take really justified managerial decisions.

Key words: atmospheric air, monitoring, atmospheric particulate matter (particulates), carcinogenic and non-carcinogenic risks.

One of the instruments of the Federal Control Service in the sphere of consumers' protection and human well-being of the Russian Federation, the basis for decision-making in the sphere of healthcare and sanitation and ensuring epidemiological well-being of the population is social-hygienic monitoring. An important element of social-hygienic monitoring is a laboratory control of the life environment quality. The application of the methodology of risk assessment allows to expand and deepen the interpretation of the laboratory control results and to reasonably plan preventive measures, calculate economic losses [1,2]. On the whole, the methodology of risk assessment

was considered as one of the basic backbone elements of social-hygienic monitoring [1,3,4].

Kazan, the administration center of the Republic of Tatarstan, was chosen as a subject of research. The city has long been a developed industrial center with more than a hundred of major, medium and small industrial enterprises and the intensity of traffic load is really high.

Annually about 360 kinds of chemical pollutants with the total mass of about 100 thousand tons are emitted into the atmosphere. The share of industrial waste of the total pollution is around 27-30% [4,5]. Among the admixtures deteriorating the quality of city air are toxic sub-

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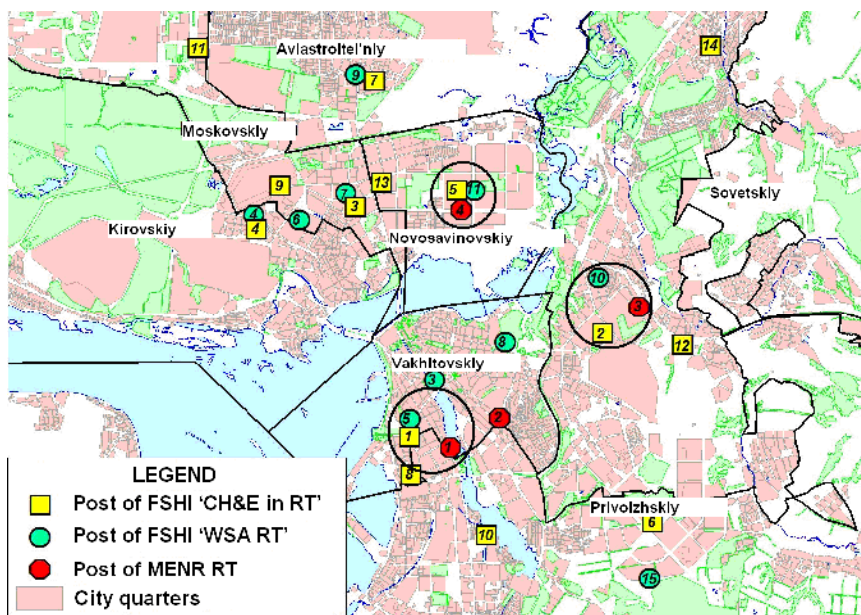
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stances of the first and second danger classes (chrome, benzole, carbolic acid, acrylic aldehyde, formaldehyde) and the substances having a low level of irritant effect (hydrogen disulfide, ammonia, caustic soda, etc.). More than 67% of all the emissions of stationary sources are produced by CJSC Kazanorgsintez, about 10% are emitted by TPP-1. The substantial pollution is produced by TPP-2, Municipal Unitary Enterprise, Production Unity Kazenergo, LLC Kazan Factory of silicate wall materials and so on.

The zone division in the city is not very obvious. The residential area in a number of cases is adjacent to production sites. With the total amount of transport vehicles registered in the city which is about 277 thousand, the traffic load on the main city highways reaches 3,500-6,000 vehicles per hour. The condition of the life environment indicates the presence of risks and dangers for the health of the population [6-8].

The aim of this work was the risk assessment from the effect of chemical substances polluting the air for the health of the population of Kazan based on the data of laboratory-instrumental research by three different agencies.

The instrumental monitoring of the atmospheric air in Kazan is represented by the systems of observation of three different agencies: Federal State-funded Healthcare Institution 'Center of hygiene and epidemiology in the Republic of Tatarstan (Tatarstan)' (hereinafter referred to as FSHI 'CH&E in RT') – 14 posts of monitoring; the Ministry of Ecology and Natural Resources of the Republic of Tatarstan (hereinafter referred to as MENR RT) – 4 automated stations of atmospheric air pollution control (ASAAPC) and Federal State-funded Healthcare Institution 'Weather Services Agency (hereinafter referred to as FSHI 'WSA RT') – 10 posts of air pollution observation (APO)(Pic. 1).



Pic. 1 Map of Kazan with the posts of air pollution observation

The air samples selection in the city is conducted in the places of big traffic junctions, in the sector of major production sites as well as in the places of mass sports competitions which was connected with the hosting of International Universiade by Kazan [4].

There are 3 districts in Kazan selected for the analysis with posts of air pollution observation of all the three agencies located compactly:

- Vakhitovskiy district occupies the central part of the city including the historical center of

Kazan. The total number of inhabitants living permanently is about 83 thousand people;

- Sovetskiy district occupies the north-eastern and eastern parts of Kazan. Population is over 272.5 thousand people;

- Novo-Savinovskiy district is the most densely populated district occupying the central-north-western part of the city. Number of inhabitants is over 205 thousand people.

On the whole, the research comprised 64% of the population of Kazan.

Aiming at accuracy in comparing results of the air samples selection, the territories are chosen in the way that within their boundaries the distance between the observation posts of the given agencies is not more than 1.5 kilometers.

In table 1 there is a list of observation posts of agencies on the studied territories.

Table 1

Atmospheric pollution observation posts on the analyzed territories in Kazan in 2012.

Agency name	Observed territories		
	Vakhitovskiy	Sovetskiy	Novo-Savinovskiy
Federal State-funded Healthcare Institution 'Center of hygiene and epidemiology in the Republic of Tatarstan'	1	2	5
Ministry of Ecology and Natural Resources of the Republic of Tatarstan	1	3	4
Federal State-funded Healthcare Institution 'Weather Services Agency	5	10	11

The biggest number of researches are held on ASAAPC (automated stations of atmospheric air pollution) of the Ministry of Ecology and Natural Resources of the Republic of Tatarstan (on certain pollutants there are over 23 thousand of researches carried out annually). Complex laboratory of life environment monitoring of FSHI 'WSA RT' on the majority of elements carries out more than 1,000 researches every year. At the places of FSHI 'CH&E in RT' monitoring there are about 100 researches on each element.

Health risk assessment was held under R 2.1.10.1920-04 'Guidelines on population health risk assessment from chemical substances polluting the life environment'.

The analysis of the conducted laboratory-instrumental studies of the atmospheric air in Kazan showed that the above-given agencies investigate the concentrations of 27 various pollutants (further on pollutants). The majority of them are in the list of the priority substances contained in the air environment of the cities defined both at the level of the Russian Federation¹ and at the international level²: nitrogen dioxide, sulphur dioxide, carbon monoxide, particulate matter, formaldehyde and others. In tables 2-4

annual averages of pollutant concentrations in 2012 are represented. The presented data characterized the exposition of the Kazan population and were used to calculate health risks.

В атмосферном воздухе анализируемой In the atmospheric air of the studied territory of Vakhitovskiy district there are, on the whole, about 20 pollutants being studied. The results of studies of some of those are represented in table 2.

The calculations have shown that according to the data of all the three agencies on the studied territory there are not permissible levels of non-carcinogenic health risks for the population (HQ \leq 1) from the influence of particulate matter. Besides, non-permissible risks appear from the influence of particulate matter with the particles in size fewer than 10 μ m (PM10) and fewer than 2.5 μ m (PM2.5) which are considered the most dangerous fractions and thus deserve a particular attention. In Kazan the above-named fractions are studied only by the trial laboratory center FSHI 'CH&E in RT'. The non-permissible risk levels from nitrogen dioxide are confirmed by researchers of two agencies.

Significant levels of non-cancerogenic risk from soot impact also draws our attention (it is studied only by FSHI 'CH&E in RT'). In the previous works we have performed calculations of cancerogenic risks from soot and

Table 2

Annual average concentrations of pollutants in the atmospheric air and the indicators of risks in Vakhitovskiy district in Kazan in 2012.

#	Pollutant name	MPC CC mg/m ³	R _{fc} , mg/m ³	FSHI 'CH&E in RT'		MENR RT		FSHI 'CH&E in RT'	
				C, mg/m ³	HQ	C, mg/m ³	HQ	C, mg/m ³	HQ
1	Ammonia	0,04	0,1	–	–	0,012	0,12	–	–
2	Nitrogen dioxide (as for NO ₂)	0,04	0,04	0,090	2,244	0,024	0,6	0,11	2,75
3	Nitrogen monoxide	0,06	0,06	–	–	0,038	0,633	–	–
4	Sulphur dioxide	0,05	0,02	0	0	0,003	0,15	–	–
5	Particulate matter	0,15	0,04	0,150	3,759	0,42	10,5	0,1	2,50
6	Particulate matter PM ₁₀	0,06	0,05	0,098	1,958	–	–	–	–
7	Particulate matter PM _{2.5}	0,035	0,015	0,052	3,499	–	–	–	–
8	Formaldehyde	0,061	0,003	0,002	0,71	–	–	0,01	3,33
9	Benzole	0,1	0,03	0,000	0	0	0	0	0
10	Carbon monoxide	3	3	3,097	1,032	0,713	0,238	1	0,33
11	Carbon (soot)	–	0,01	0,136	13,580	–	–	–	–
12	Methane	–	50	–	–	2,49	0,050	–	–
13	Hydrogen sulfide	–	0,02	–	–	0,001	0,05	–	–

Note: MPCs - the maximum permissible concentration; Rt - the reference concentration; C - the concentration of the substance; HQ - hazard ratio.

formaldehyde where we received non-permissible levels of risk. It should be noted, that as for FSHI 'WSA RT' data, on the given territory the formaldehyde concentration in the atmospheric air is significantly higher and the risks (on its basis) exceed all the permissible levels. Thus, formaldehyde and soot are most dangerous for population health because they

are pollutants creating cancerogenic and non-cancerogenic risks.

It should also be noted that exceeding MPC_{cc} and high levels of risks according to the FSHI 'CH&E in RT' data might be caused by the fact that annual average concentrations of pollutants are calculated also taking into account the results of maximum one-off studies.

Table 3

Annual average concentrations of pollutants in the atmospheric air and indicators of risks in Sovetskiy district in Kazan in 2012.

#	Pollutant name	MPC CC mg/m ³	R _{fc} , mg/m ³	FSHI 'CH&E in RT'		MENR RT		FSHI 'CH&E in RT'	
				C, mg/m ³	HQ	C, mg/m ³	HQ	C, mg/m ³	HQ
1	Ammonia	0,04	0,1	–	–	0,003	0,03	0,01	0,1
2	Nitrogen dioxide (as for NO ₂)	0,04	0,04	0,105	2,625	0,092	2,3	0,07	1,75
3	Nitrogen monoxide	0,06	0,06	–	–	0,048	0,8	–	0
4	Sulphur dioxide	0,05	0,02	0,00	0	0,005	0,25	0	0
5	Particulate matter	0,15	0,04	0,153	3,833	0	0	0,06	1,5
6	Particulate matter PM ₁₀	0,06	0,05	0,041	0,823	–	–	–	–
7	Particulate matter PM _{2.5}	0,035	0,015	0,025	1,656	–	–	–	–
8	Formaldehyde	0,061	0,003	–	0,077	–	–	0,004	1,333

9	Carbolic acid	0,003	0,006	–	–	–	–	0,001	0,167
10	Carbon monoxide	3	3	3,874	1,291	1,159	0,386	1,2	0,4
11	Carbon (soot)	–	0,01	0,168	16,83	–	–	–	–
12	Methane	–	50	–	–	3,490	0,070	–	–
13	Hydrogen sulfide	–	0,02	–	–	0,005	0,250	0	0

In Sovetskiy district as well as in Vakhitovskiy district the results of studies of two agencies confirm the non-admissible levels of health risks. The results of atmospheric air studies in Sovetskiy district in Kazan are represented in table 3.

As for the particulate matter on the studied territory non-admissible levels of risk for non-cancerogenic effects are formed based on the data of FSHI 'CH&E in RT' and FSHI 'WSA RT'. In 317 studies of MENR RT particulate matter has not been found. Besides, there are lower indicators of risks from PM 2.5 fraction influence than in Vakhitovskiy district. As for fraction PM10 the indicators do not exceed the permissible levels. Also, high indicators of non-

cancerogenic risks in Sovetskiy district are not formed as a result of soot influence.

In Novo-Savinovskiy district the studies of all the three agencies confirm non-permissible levels of risk from particulate matter impact. The results of the atmospheric air studies in Novo-Savinovskiy district of Kazan are represented in table 4.

With maximum levels of risks found by the studies of MENR RT (11,022 studies). Unfavourable effects are to be expected from the impact of PM10 and PM2.5 particulate matter fractions. High levels of non-cancerogenic risk are formed from the impact of soot and nitrogen dioxide.

Table 4

Annual average concentrations of pollutants in the atmospheric air and indicators of risks in Novo-Savinovskiy district in Kazan in 2012.

#	Pollutant name	MPC CC mg/m ³	R _{fc} , mg/m ³	FSHI 'CH&E in RT'		MENR RT		FSHI 'CH&E in RT'	
				C, mg/m ³	HQ	C, mg/m ³			
1	Ammonia	0,04	0,1	–	–	0,115	1,15	0,01	0,1
2	Nitrogen dioxide (as for NO ₂)	0,04	0,04	0,09499	2,37	0,06	1,5	0,08	2
3	Nitrogen monoxide	0,06	0,06	–	–	0,047	0,783	–	–
4	Sulphur dioxide	0,05	0,02	0,00	0	0,007	0,35	0	0
5	Particulate matter	0,15	0,04	0,114	2,860	0,77	19,25	0,06	1,5
6	Particulate matter PM10	0,06	0,05	0,090	1,805	–	–	–	–
7	Particulate matter PM2.5	0,035	0,015	0,038	2,564	–	–	–	–
8	Formaldehyde	0,061	0,003	0,001	0,323	–	–	0,004	1,333
9	Carbolic acid	0,003	0,006	–	–	–	–	0,001	0,167
10	Carbon monoxide	3	3	3,054	1,018	1	0,333	1,16	0,387
11	Carbon (soot)	–	0,01	0,118	11,752	–	–	–	–
12	Methane	–	50	–	–	1,48	0,030	–	–
13	Hydrogen sulfide	–	0,02	–	–	0,008	0,4	0	0

Thus the analysis of the studies results demonstrated that in Kazan there are non-permissible levels of risk formed from the impact of particulate matter which is confirmed by the study results of three various agencies.

The greatest danger is represented by dust particles in size less than 10 and 2.5 μm whose influence forms non-permissible levels of risks for non-cancerogenic effects on almost all the studied territories.

The problem of decreasing carbon monoxide, nitrogen dioxide emissions which are the components of automobile exhaust fumes is still topical. According to the information of the three agencies there are non-permissible for the population both cancerogenic and non-cancerogenic health risks.

Laboratory data of FSHI 'WSA RT' indicate formation of non-permissible level of non-cancerogenic risk from the impact of formaldehyde which is, however, not confirmed by the studies of FSHI 'CH&E in RT'.

The conducted analysis demonstrated that, that on the whole, according to the data of the three agencies there is a situations of mutual confirmation of the study results of the atmospheric air (on particulate matter and nitrogen dioxide). Data verification and objectiv-

ity confirmation of the data extracted allow to develop an objective assessment of the population health risk determined by atmospheric air factors. Nevertheless, there is a number of differences in the results on certain pollutants (formaldehyde, carbon monoxide) which doesn't allow to interpret the obtained results precisely and take justified and reasonable managerial decisions. There is a point in conducting arbitration studies and eliminating system discrepancies in the obtained results.

It is also seen as important to perform a comparative analysis of the laboratory study results on the observation posts of all the three agencies and data of pivot volume of maximum admissible emissions in Kazan which would take into account the emission of stationary and mobile sources of the city.

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