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RISK ASSESSMENT AS A CRITERION OF ENVIRONMENTAL STRESS

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Abstract:
The existence of a close relationship between the morbidity of population and the quality of water supply and air was noted a long time ago. In recent years, there is an acute crisis in the freshwater system, including drinking water. According to the World Health Organisation (WHO), infectious morbidity of population, associated with water supply, comes up to 500 million cases per year. These data give reasonable grounds for calling the problem of water supply with pathogen-free drinking water in sufficient amount as the worldwide problem number one. For validation the hygienic standards of drinking water quality, comprehensive complex studies are carried out. The main indicators of drinking water quality are divided into several groups. The group of organoleptic indicators (aftertaste, smell, colour and turbidity) can be assessed by the population, who consume drinking water. The sociological study on the population's assessment of the quality of tap water and air was conducted. The analysis of chemical content of water and air was carried out, and the risk levels were assessed.

Keywords: *zoning, quota sample, level of pollution, water quality, level of pollution, risk.*

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INTRODUCTION:

The impairment of water and air quality adversely affects the population [1]. Consumption of poor quality water increases the risk of infectious diseases and exacerbation of chronic diseases among the population [1].

Sociological research in the form of population survey was carried out. People, who took part in the survey, lived near the large economic entities. The purpose of this study was to define the features of the impact of air and water, with various levels of pollution, on the city residents, and the risk assessment [2, 3, 4].

The object of this study is the children and adults, living within 4.8km radius of large economic entities.

The region, investigated by us, includes three settlements. The housing stock of the district consists of 908 houses, 257 of which are individual buildings.

Industrial enterprises of the studied region represent different branches of the economy (the leading branch is the chemical industry). The largest chemical enterprises of the city and other factories of chemical and petrochemical industry, machine-building, timber and woodworking enterprises, the plants of building materials and food industry are located on the territory of investigated region.

The studied area was conditionally divided into 5 zones. The zone number one is a residential area, located in the north-eastern part of the researched district. Herewith, the investigated district occupies the central-north-western part of the city.

METHODS:

Such methods of survey as questioning and interviewing of children and adults were used in the research process. Sampling of air, water and soil was conducted, in order to define the content of chemicals. The human health risk assessment as a result of the impact of polluted air, drinking water and soil was carried out [2, 3, 4]. To study this problem, zoned, quota sample was used. We conducted an assessment of the health risks of people, living in the area within a radius of 4.8 km from the chemical plant, exposed to the influence of polluted air, drinking water and soil [2, 3, 4]. 1400 people took part in the investigation. The survey of children was carried out by the method of personal interviews of parents in pre-school and school educational institutions. The survey was conducted with the permission of teachers and parents.

The survey of adults, aged 18-80, was conducted by the method of personal interview, at the place of living of the respondents. The survey was conducted in residential areas, located within a radius of 4.8 km from a large chemical plant. Five main zones were defined. Sampling of air and water was conducted in all zones of the investigated district [5, 6, 7].

Risk assessments have been carried out, in order to identify and predict the adverse impact on human beings of harmful chemicals and compounds, polluting the living environment. The toxic properties of substances, the degree of pollution, the migration of toxic substances in the environment, and the ways of exposure to human health were taken into account [8, 9]. In this study, the risk is considered as the probability of development of adverse health consequences of technogenic environmental pollution among the population, living near the large economic facilities [9, 10].

RESULTS:

After the statistical analysis and processing of the data of our studies, the following results were obtained. The main place of stay of residents from zone number one on weekdays is their area of living (30.2%) and neighbouring areas with a place of residence (38.1%). The dynamics of population migration increases in summer.

The analysis of water consumption found that in summer season, the greatest time expenditure for washing was observed among men at the age of 16-18 (13.5 min), and in 2-year-old boys (17 min); among women at the age of 16-18 (14.5 min) and in 19-20-year-old girls (27 min). In winter season, the indicators are increased in all age groups.

Consumption of water with food among the adult population at the age of 19-60 is about 3 litres per day. In winter season, the water consumption is reduced to 2 litres per day. In children, there is no significant difference in water consumption by seasons; it increases in accordance with the age.

The quality of tap water causes concern in 67.4% of respondents, 32.6% of people don't worry about it. The main reasons for concern are the following: smell - 45.5%, taste - 40.1%, colour - 25.3%, turbidity - 25.3%. Respondents prefer to consume tap water after additional treatment - 47.85%. Bottled water is used by 20.98% of the surveyed population, other water – by 2.47%.

Contact with soil occurs more often in children under the age of 5 years in summer: 55 min on the sand,

and 47 min on the ground, in winter – 14 min and 29 min, respectively. Children at the age of 6-10 years contact with soil more than others in summer (52 min), and 16-18-year-old respondents - in autumn and in spring (48 min).

The respondents note the presence of discernible smell at home in the morning (30.8%), in the night-time (25.4%), in the evening (24.6%). The smell near the house is noted in the evening (31.8%), in the morning (25.4%), in the night time (22.2%). The presence of a very strong smell is observed by the respondents in the evening (12.9%), and in the morning (9.4%). They note the smell of gas (17.8%), the smell of phenol (14.4%), the smell of chemicals and household waste (13.2%), the smell of faeces (10.6%), the smell of landfill (6.6%), heavy and misty air (5.6%), the smell of medicines (3.7%), the smell of burning (3.4%) and acetone (3.4%). According to the respondents of the region, the main source of odours is the chemical plant (53.9%), the landfill of solid household waste (17.7%), the plant of chemical and pharmaceutical industry (9.8%), the poultry farm (6.4%). Only 1.4% of all respondents consider the city as clean from smells.

The analysis of data of the conducted research allowed to obtain the following results: the presence of 19 priority pollutants was revealed in the investigated zone, taking into account the background pollution of atmospheric air.

The tendency of substances' reduction is observed with the remoteness from the sources of pollution. The fact of distribution of the largest values with the prevailing wind direction is defined.

The first place in the formation of individual carcinogenic risks in the residential area is benzene, epoxyethane, hexavalent chromium and divinyl.

For zone number one of the studied area, the inhalation route is predominant (63.48%). This is due to the intake of benzene, epoxyethane, hexavalent chromium and divinyl from atmospheric air. The total carcinogenic risk from atmospheric air in regards to benzene, epoxyethane, hexavalent chromium and divinyl was $6.74 * 10^{-5}$.

The values of carcinogenic risks in case of dermal intake are the following: intake of cadmium - CR = $6.9 * 10^{-8}$; chloroform - CR = $3.7 * 10^{-7}$; intake of lead with drinking water - CR = $8.3 * 10^{-10}$.

The values of carcinogenic risks in case of oral intake are as follows: intake of cadmium - CR = $1.2 * 10^{-6}$; chloroform - CR = $9.8 * 10^{-6}$; intake of lead with drinking water - CR = $2.7 * 10^{-6.}$

Calculations of hazard indices (HI) gave the following results: the hazard index of cardiovascular system (HI up to 1.65 - taking into account the background, up to 1.58 - without consideration of background); blood system (HI up to 1.51 – taking into account the background, up to 1.46 – without consideration of background); immune system (HI up to 1.36 - taking into account the background, up to 1.26 – without consideration of background), due to ethylene. The hazard index of respiratory organs was (HI up to 1.34) due to a mixture of saturated hydrocarbons C1-C5 by pentane. The hazard index of the central nervous system was (HI up to 1.15) - due to benzene.

The calculation of HI indices of chronic effects of reproductive system was (HI up to 0.69), the processes of organism development (HI up to 0.54), liver (HI up to 0.23), kidneys (HI up to 0.18), eyes (HI up to 0.08), hormonal system (HI up to 0.0003).

Lead and cadmium were found in the soil. The total carcinogenic risk is formed at such levels, which are considered by all people as negligible, not differing from ordinary, everyday risks (de minimis level). These risks do not require additional measures for their reduction, and their levels are only the subjects of periodic control.

The maximum values of HI for lead: in case of oral intake = $1.27 * 10^{-5}$, in case of dermal exposure - $3.69 * 10^{-6}$, in case of inhalation intake - $9.68 * 10^{-9}$.

Carcinogenic risk from the impact of lead through the drinking water is formed at the level of $2.61 * 10^{-6}$, cadmium - $1.05 * 10^{-6}$, chloroform - $9.71 * 10^{-6}$.

The intake of carcinogens by oral route from the soil corresponds to such levels, which are considered by all people as negligible, not differing from ordinary, everyday risks (de minimis level). The contribution of cutaneous route to the level of total carcinogenic risk is 0.43%.

The total carcinogenic risk in case of multimedium exposure is formed at the level of $1.02 * 10^{-4}$ (corresponding to the upper limit of the acceptable risk). These levels are subjected to constant control.

DISCUSSION:

The health of each person or the whole population depends on many factors. In recent years, the average life expectancy of Russian people has decreased

significantly. There is a reliable fact of growth of morbidity and disability, the decrease in the number of able-bodied citizens of the country. Unfavourable ecological factors are a high level threat and cause significant damage for the whole society. First of all, this is due to the loss of temporary and permanent work capacity, which requires high costs for prevention, treatment and rehabilitation. Industrial pollution of the environment causes significant damage to the health of population. This is directly related to the development and a sharp increase in chemical production in recent years. The reproductive health of population reduces due to the toxic effects of chemicals. This study is aimed at defining the quality of water and air, in residential areas, located near the large industrial facilities. Statistical processing of data, obtained as a result of survey, gave the following results:

The quality of tap water causes concern among the majority of residents of the zone number one. First of all, this is due to the presence of foreign smell; the presence of off-flavour taste is at the second place. Next, there are the colour and turbidity of water. For this reason, the residents of studied area prefer the consumption of tap water after additional treatment, and the consumption of bottled water. Most of the respondents noted the presence of discernible smell, which intensifies in the evenings.
In the process of characterization the risk in the studied residential area, we defined that benzene, epoxyethane, hexavalent chromium and divinyl were the leading factors in the formation of individual carcinogenic risks from pollutants, contained in the air.

In recent years there has been a significant increase in congenital anomalies and the appearance of tumors in early childhood, as well as the growth disorders and functional disorders in children. Pollution of atmospheric air causes the development of environment illnesses. It has been scientifically proven that the carcinogenic risk and the risk of development of non-carcinogenic effects are most often formed due to the exceeding concentrations of pollutants in atmospheric air. Long-term impact of pollutants can lead to chronic diseases. The degree of pollutants influence is still difficult to classify uniquely, since they are very diverse. Although they occur in relatively low concentrations, they give a delayed effect. The pollutants are conventionally divided into air pollutants (aeropollutants), water pollutants (hydropollutants) and land pollutants (terrapollutants), depending on the area of pollution.

In the zone under study, the presence of an increased content of such aeropollutants as benzene, epoxyethane, chromium VI, divinyl, ethylene was noted.

14 hydropollutants were revealed: aluminum, ammonia, iron, calcium, nitrates, nitrites, cadmium, lead, copper, zinc, residual bound chlorine, petroleum products, chloroform, fluorides, including 3 carcinogens (lead, cadmium, chloroform).

The terrapollutants, found in the zone number one of the studied area, are the following: ammonia, nitrates, mercury, copper, petroleum products, zinc, including 4 carcinogens - cadmium, lead, benzene, ethylbenzene.

SUMMARY:

1. As a result of the conducted research it was proven that the source of priority pollutants is a petroleum chemical plant.
2. The characteristics of risk in the studied area, taking into account background air pollution, allows to reveal that carcinogenic risks in the research territory are formed by 19 priority pollutants.
3. The leading place in the formation of individual carcinogenic risks in the residential area is occupied by benzene, epoxyethane, chromium hexavalent and divinyl.
4. In the studied zone, the total carcinogenic risk from air polluted by benzene corresponds to the maximum permissible risk (the upper limit of acceptable risk) and is subjected to constant control. The hazard index of cardiovascular system for ethylene is 1.66; the HI of the nervous system is 1.36.
5. The level of carcinogenic risks in case of dermal intake of cadmium, chloroform and lead with drinking water is in the first range of risk, and characterizes such levels of risk, which are considered by all people as negligible, not differing from ordinary, everyday risks (de minimis level). Such risks are subjected to periodic monitoring.
6. The level of carcinogenic risks in case of oral intake of cadmium, chloroform, and lead with drinking water conforms to the second range of the system of risk acceptability criteria, that corresponds to the maximum acceptable risk (the upper limit of acceptable risk) and is subjected to constant monitoring.
7. Calculations of hazard indices (HI) indicate the probability of development of chronic diseases of cardiovascular system, blood system, immune system (due to ethylene). There is also the possibility of development of chronic diseases of respiratory system and central nervous system (respiratory organs - due to a mixture of saturated hydrocarbons C1-C5 by pentane, CNS - due to benzene). Also, the

calculation of hazard indices shows the permissible probability of development of chronic effects of reproductive system, liver, kidneys, eyes, hormonal system and the processes of organism development.
8. Carcinogenic risk from the influence of lead, consumed with drinking water, cadmium and chloroform, corresponds to the maximum permissible risk (the upper limit of acceptable risk) and is subjected to continuous monitoring.

CONCLUSIONS:

According to the WHO, environmental factors form up to 25% of human pathologies, and cause premature mortality. The pursuit of technical innovation and comfort has brought the atmosphere, soil and drinking water into a condition, almost unsuitable for life. There is a significant increase in the morbidity of population in the areas, located near production facilities, which are characterized by harmful emissions to the atmosphere and water bodies. The presence of heavy metals in water and soil has become an environmental problem for large cities. It is a distinctive feature of the residents of industrial zones. The poisoning, caused by heavy metals and dioxides, entering the atmosphere from industrial plants, leads to immune depression. In turn, the weakening of human immune system, due to deteriorating environmental conditions, leads to a syndrome of chronic fatigue. According to the WHO, water can contain up to 13 thousand of potentially toxic elements. It has been proven that heavy metals such as lead, mercury, cadmium, zinc, nickel and chromium cause atherosclerosis, polyneuritis, hypertension, marrow failure, impaired vision. Uranium, plutonium, thorium and strontium lead to oncological diseases, genetic changes, weakening of immunity and congenital malformations. Fluorine, chlorine and its compounds (bromine and chloroform) cause nephritis, hepatitis, toxicosis of pregnancy. These toxic substances lead to the development of congenital anomalies of fetus, have a mutagenic effect, lead to the weakening of immune system, affect the genital functions of men and women, cause oncological diseases of the internal organs.

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