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MODERN APPROACHES OF ESTIMATION OF RISK FACTORS INTERMITTENT INFLUENCE

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Abstract: We studied the quality of three environmental objects of the population living in a large industrial city (atmospheric air, soil and drinking water). We also determined the content and quantity of chemicals in the habitat of the population living near large industrial enterprises. We presented the results of the calculations of hazard indexes (HI), on the basis of which we derived the risk features of the development of non-carcinogenic effects of exposure to the body of chemical compounds (with combined and complex exposure). Non-carcinogenic risk is defined as an indicator of the expected increase in the incidence of the population due to the toxic properties of foreign chemicals in the studied environmental objects. The main objective of our socio-hygienic study was to identify chemical factors in the environment that are potentially hazardous to the life and health of children and adults living within a radius of 4,800 meters from an industrial enterprise in a large industrial city when received in different ways (combined)

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and assess the risk of violations in human health of varying severity when exposed to non-carcinogenic chemicals.

Keywords: questioning, interviewing, pollution degree, water quality, non-carcinogenic risk, hazard index, toxicity.

Introduction

In recent years, many authors have noted a sharp deterioration in the quality of tap water consumed by the population and the presence of extraneous irritating odors in the air [1, 2, 3, 4]. At the same time, it is also noted that the quality of tap water almost does not reach the minimum standards for compliance with the purity of consumed water in many large cities. The consumption of low-quality water and the presence of extraneous annoying odors in the air leads in turn to a significant deterioration in well-being, poor health and sharp increase in the incidence among the population (the risk of infectious diseases, the risk of exacerbation of chronic diseases and the risk of cancer among the population increase significantly) [2, 3.4].

At the second UN conference on environment and development (Rio de Janeiro, June 1992), it was noted that humanity is on the verge of a possible environmental disaster [Koptyug, 1993].

We conducted a socio-hygienic study in order to identify the effects of atmospheric air, tap water and soil of varying degrees of pollution on children and adults living in the region where industrial enterprises of large industrial cities operate (within a radius of 4,800 meters from a large chemical enterprise). To conduct research, we chose the region most saturated with various industrial enterprises (with a predominance of chemical enterprises) [5].

When conducting the analytical part of the study, such facts as the age of respondents, gender, length of stay in the research area, migration during the year (time of absence in the living area during the year and duration of absence in the living area during the day) were taken into account. We also took into account the contact time with soil and water (seasonally adjusted), time spent indoors, time spent outdoors.

Depending on the remoteness and geographic location of the largest chemical plant in the city, the region under study in a radius of 4,800 meters was conditionally divided into 5 areas.

The area closest to the enterprise is located to the north-eastern part of the investigated area.

Methods

Our study amounts 1,400 children and adults living in a large industrial city in the area of a radius of 4,800 meters from the industrial enterprise. During technical part of the study, we used questionnaires and special forms developed for this study (specialized for children and adults). Data was collected in 3 objects of the population's environment (in atmospheric air, soil and tap water) concerning chemicals that could be potentially dangerous or negatively affect the health of children and adults living in the research area. Laboratory studies were conducted of samples taken in the research area for the content of chemicals. Based on the results of comparing the statistical processing of the data obtained by questioning and interviewing the children (in the presence of parents or guardians) and the adult population with the results of laboratory data on the content of chemicals in the atmospheric air, soil and tap water, we carried out an assessment of the risk to the health of the population living in the research area. We evaluated the carcinogenic and non-carcinogenic risk of the chemicals found in the household drinking water, soil and atmospheric air of the research area.

We carried out a statistical analysis of the hazard for children and adults, taking into account the concentration of chemicals in the environment. We prepared a list of priority chemical compounds subject to regular monitoring [6].

We also made an assessment of the risk of exposure to public health of potentially hazardous chemicals (taking into account toxic properties) found in the study. Risk assessments were carried out taking into account the degree of concentration of chemicals in the air, tap water and soil. We took into account the ways of exposure to humans of the detected toxic chemicals and their migration in the studied environmental objects.

In our study, risk is considered as the probability of the development of consequences of technogenic pollution of the studied three environmental objects for the health of the population living in the research area.

In this study, we characterized the risk of developing non-carcinogenic effects for the individual substances according to the formula:

HQ = AD / RfD or HQ = AC / RfC,

where HQ – hazard factor; AD – average dose, mg/kg; RfD – reference (safe) dose, mg/kg; AC – average concentration, mg/m3; RfC – reference (safe) concentration, mg/m3 [7].

For the conditions of the simultaneous entry into the human body of several toxic substances from the environment in the same way, the hazard index was calculated by the formula:

$HI = \Sigma HQ_i$[7].

Under the condition of a complex supply of a chemical at the same time in several ways, the risk criterion is the total hazard index, which was calculated by the formula:

$THI = \Sigma HQ_j$ (as well as multi-media and multi-route impact) [7].

When conducting a risk assessment (calculation of hazard indices) for non-carcinogenic effects, we considered the risk additivity (summation) approach to be the most preferable [7].

Results

An assessment of the non-carcinogenic risk for chronic inhalation of chemicals in this study was carried out for 40 substances found in emissions from the main industrial site. It also relates to chemicals contained in the emissions of the base stock SUS and priority ones for the impact on public health identified by ranking results at the stage of “Hazard identification”.

The leading place in the formation of individual non-carcinogenic risks in the residential area is occupied by ethylene (contribution from 80.42 to 85.06%, depending on the distance from the industrial enterprise). The second place is occupied by a mixture of hydrocarbons C1-C5 for pentane (contribution from 51.89 to 56.61%). The study showed that the inhalation route is preferable for the area number one of the research areas. The total non-carcinogenic risk from atmospheric air for benzene, epoxyethane, chromium VI and divinyl was 6.69 * 10-5.

The analysis results of the assessment of chronic non-carcinogenic risk when using MAC (maximum allowable concentrations) were lower than when using RfC. the following values were obtained When assessing chronic non-carcinogenic risk: from exposure of chloroform (HQ = 5.87*10-3), ammonia (HQ = 2.19*10-4), lead (HQ = 2.69*10-5) , cadmium (HQ = 1.78*10-5), zinc (HQ = 1.58*10-6), fluorides (HQ = 3.09*10-3), copper (HQ = 1.53*10- 5), aluminum (HQ = 7.69*10-5). The values obtained with the transdermal intake of these chemicals are significantly lower than acceptable levels.

It was not possible to calculate the risks for priority compounds (calcium, iron, residual bound chlorine, nitrites, nitrates and oil products) during skin exposure due to the lack of the octanol/water distribution coefficient (Kow), and therefore we were unable to calculate the average daily dose of the indicated chemical substances for cutaneous intake of water for household and drinking purposes.

The values of non-carcinogenic risks associated with oral administration of drinking water to water obtained by our study were significantly lower than acceptable (acceptable is 1.0). The values are as follows: for chloroform (HQ = 0.149), ammonia (HQ = 0.019), lead (HQ = 0.009), cadmium (HQ = 0.005), zinc (HQ = 0.0003), fluorides (HQ = 0.34), copper (HQ = 0.01), aluminum (HQ = 0.007), oil products (HQ = 0.009), residual bound chlorine (HQ = 0.209), nitrites (HQ = 0.028), calcium (HQ = 0.058), iron (HQ = 0.009).

The assessment results of chronic non-carcinogenic risk when using MAC show that the values of hazard coefficient (HQ) values for priority compounds are at an acceptable level throughout the residential area of the region under study, taking into account the background. Moreover, the analysis of results showed that the risks are lower than when using RfC. The results of the distribution of concentrations of chemicals obtained during the study in the residential area allow making a conclusion that their values do not exceed the corresponding MAC.

Discussion

Studies have shown that the total non-carcinogenic risk with multi-media exposure corresponds to the upper limit of acceptable risk. The level of indicators obtained during the study is subject to constant monitoring.

An assessment of chronic non-carcinogenic risk showed that the hazard coefficient (HQ) values for priority compounds are at an acceptable level throughout the study area, taking into account the background.

The non-carcinogenic risk for ethylene is HQ = 1.0 at the border of 4,800 meters, therefore the non-carcinogenic risk for ethylene approaches the reference concentration (HQ = 0.88), in the research area closest to the industrial enterprise.

Calculations of hazard indices (HI) indicate the likelihood of chronic effects from the cardiovascular system (HI up to 1.59 - taking into account the background, up to 1.54 - without taking into account the background), blood system (HI up to 1.47 - taking into account the background, up to 1.43 - without taking into account the background), immune system (HI up to 1.31 - taking into account the background, up to 1.23 - without taking into account the background), respiratory organs (HI up to 1.33) and central nervous system (HI to 1.14) respiratory organs - due to a mixture of hydrocarbons C1-C5 for pentane (contribution - 24.36%), CNS - due to benzene (contribution - 46.28).

Along with this, the calculations of hazard indexes (HI) indicate the admissible probability of the development of chronic effects from the reproductive system (HI to 0.69), the body development processes (HI to 0.53).

The likelihood of developing chronic effects from the liver (HI to 0.22), kidneys (HI to 0.17), eyes (HI to 0.07), hormonal system (HI to 0.0002).

The research results showed that the hazard coefficients (HQ) and the total risk (HI) in the residential area are at an acceptable level due to emissions from the enterprise.

The likelihood of chronic pathological effects from the bone system, teeth, blood system, kidneys, mucous membranes, central nervous system, hormonal system, liver, biochemical changes in the body, nervous system, developmental processes, reproductive, immune systems, as well as from the gastrointestinal tract (GIT), when the population of the study area uses drinking water, does not exceed the maximum permissible risk levels.

Summary

The analysis results of our study showed that the concentration of chemicals in the studied environmental objects decreases depending on the distance from the industrial enterprise. In atmospheric air, the concentration of chemicals also depends on the wind direction. These indicators give reason to assert that our study reliably proves that the petrochemical plant is the source of priority pollutants in the study area.

The risk of developing a non-carcinogenic effect in the study area (taking into account background pollution of the atmosphere) is formed by 17 priority pollutants.

Ethylene occupies the leading place among airborne pollutants forming an individual non-carcinogenic risk in the study area.

In the region under study, the total non-carcinogenic risk from atmospheric air for ethylene corresponds to the upper limit of the acceptable risk and is subject to constant monitoring.

The level of carcinogenic risks associated with the oral intake of cadmium, chloroform, lead with tap water corresponds to the second range of the system of criteria for risk acceptance, which corresponds to the maximum permissible risk (upper limit of acceptable risk) and is subject to constant monitoring.

The results of our assessment of chronic non-carcinogenic risk when using MAC showed that the hazard coefficient (HQ) values for priority compounds (taking into account the background) do not exceed the permissible level throughout the research area.

Conclusions

In recent years, many authors note in their works a significant increase in the incidence of children and adults living in areas located near large industrial enterprises (with harmful emissions into the atmospheric air and water bodies). The presence of heavy metals in soil and water consumed by the population has become an environmental problem in large cities with industrial enterprises [8]. To reduce the risk of developing a non-carcinogenic effect, it is first of all necessary to strictly control and regulate the emissions of pollutants into the atmospheric air [9].

To reduce the risk of developing the non-carcinogenic effects of children and adults living within a radius of 4,800 meters from large industrial enterprises associated with the content of harmful chemicals in drinking water, it is recommended to use bottled water and use high-purity filters and biofilters to purify household drinking water [10].

To reduce the risk of developing non-carcinogenic effects of heavy metals from the soil by the cutaneous route, it is recommended to limit contact with the soil and the departure of children and adults to ecologically safe areas.

It is necessary to regularly monitor the concentration of chemicals in environmental objects (atmospheric air, soil, tap water) and not exceed the permissible level (indicators shall be at an acceptable level or lower than RfCi).

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