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METHODOLOGICAL ASPECTS OF NONCANCER GENESIS RISKS FORMATION

Ekaterina V. Vasilyeva[1]*, Irina D. Sitdikova[1], Marina K. Ivanova[4], Farit W. Khuzikhanov[2], Almaz A. Imamov[2], Elmira N. Mingazova[3], Natalia A. Makarova[2]

[1]*Kazan Federal University, Institute of Fundamental Medicine and Biology, 420008, Kazan, 18 Kremlyovskaya str., RUSSIA*

[2]*Kazan State Medical University of Ministry of Health of the Russian Federation, 420012, Kazan, 49 Butlerova str., RUSSIA*

[3]*N.A. Semashko National Research Institute of Public Health, 105064, Vorontsovo Pole str., 12-1, Moscow, RUSSIA*

[4]*Izhevsk State Medical Academy, Faculty of Pediatrics, 12 Communars str., Izhevsk, RUSSIA*

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ABSTRACT

The objective of this work was to qualitatively and quantitatively assess the concentrations of hazardous trace elements in the water used and the inhaled atmospheric air. The object of study was a residential area located 1990 meters from a pollution source - a petrochemical plant. During its operation cycle, the industrial enterprise releases into the atmosphere the processing products of petroleum raw materials, which include non-carcinogenic substances such as ethylene, ammonia, zinc, aluminum, copper, and C1-C5 carbons. The study involved a sociological survey of the main population of the studied residential area. The results of the survey revealed that the majority of the respondents noted deterioration in the taste of drinking water, stinking odor in the inhaled air, and deterioration in their health due to the products of the petrochemical enterprise. The result of the study was the identification of the main risks, their assessment was made, and hazard coefficients and indices were calculated. The most vulnerable human body systems were determined, and particular substances were identified, which the accumulation leads to the onset of pathological processes in the body.

KEY WORDS
environmental pollution, non-carcinogenic risk, risk assessment, technogenesis, petrochemical enterprise

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***Corresponding Author**
Email:
katvit95@mail.com
Tel.: +7 (937) 002-87-80

INTRODUCTION

The intensive development of various industrial enterprises leads to a steady increase in the number of patients whose pathologies directly depend on the activities of plants [1]. Based on the above, the objective of our work was to determine the specifics of the development of non-cancer risks in the study area located 1990 meters from the source of pollution. The residential area is under the influence of petrochemical techno-genesis. During the operation of the plant, the products of its vital activity inevitably enter the atmosphere, for example, the petrochemical enterprise we are studying releases about 14313 tons of polluting microelements into the environment. Such an impact adversely affects the population of a nearby residential area and provokes many negative factors. Non-carcinogenic risks are the risks that arise due to the effect of toxic microelements on the human body, cause many chronic diseases but do not lead to the development of oncological abnormalities. To identify a particular risk, a number of manipulations are necessary, the results of which will make it possible to predict the occurrence of various occupational diseases. In other words, these studies are an assessment of the risk that workers have due to the specifics of their work, as well as due to the influence of toxic substances. Non-carcinogens, like other substances, enter the human body orally, through the water used in food, through the inhaled air, and also percutaneously, i.e. upon contact of the toxic substance with the skin [3].

Summarizing the foregoing, we can conclude that the inhabitants of the studied settlement are daily affected by various toxic microelements that tend to accumulate in the human body, an excess of which leads to the development of chronic diseases, and even to death if the contact is too prolonged [4].

MATERIALS AND METHODS

The research method is to determine the hazard coefficient and hazard index. The result will be a pollutant exposure risk assessment [5]. Hazard coefficient (HQ) is the ratio of the level of an external toxic macro element (dose and concentration of a substance) to its safe, i.e. acceptable level. Hazard index (HI) is the sum of the hazard factors of various pollutants. Risk assessment is carried out gradually as follows: identification of priority pollutants; identification; assessment of the dose-response system; risk profile [6].

At the first stage, sampling is performed. This is necessary to identify the degree of risk and assess the qualitative and quantitative analysis of toxic macro elements (exposure assessment) in work areas by the level and time of exposure of substances to humans, as well as to determine the ratio of the data obtained with their maximum permissible values.

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In the subsequent stages, depending on the obtained results of the samples, either a dose-response estimate is identified, or thresholds, concentrations and uncertainty factors are determined.

The potential hazard coefficient is the ratio of the actual concentration of a toxic element in the environment (C) to the maximum permissible concentrations of the same element (MPC). The coefficient of potential hazard is determined by the formula:

R=C/MPC,

This formula is valid only when exposed to one pollutant. The population of the residential area is influenced by many factors, therefore, all hazard factors from various elements will be summarized.

When exposed to a set of substances, the following condition applies: the potential danger from trace elements should not be higher than when exposed to a single element. For this, the sum of the potential hazard coefficients from each element should not exceed a unit:

C1/MPC1+ C2/MPC2+...+Cn/MPCn≤1.

Children aged from 1 to 7 years were surveyed in preschool educational institutions through interviewing their parents. Respondents aged from 7 to 17 years were polled personally, in the territory of secondary educational institutions. For questioning in preschool institutions and schools, permission was received from their directors on the basis of an information letter from the Chief Physician of the Center for Hygiene and Epidemiology of the Republic of Tatarstan. The adult population was interviewed at the place of residence. The age of respondents was from 18 to 80 years. Written consent from the subjects was taken and the study was approved by the Kazan University ethical committee.

RESULTS

The results of the analysis of the potential danger of pollutants emitted into the environment by a petrochemical plant to the health status of residents of a residential area located 1990 m from a pollution source found that the most toxic trace elements are ethylene, ammonia, zinc, aluminum, copper, and C1-C5 carbons.

It was found that pollutants enter the body in two ways: through inhaled atmospheric air and water, both orally and when in contact with skin.

Risk calculations determined that the main toxic components in the air are ethylene and C1-C5 carbons. Both substances are non-carcinogenic and cause great harm to the health of the population of the study area. The accumulation of ethylene in the cells of the body adversely affects the functioning of the cardiovascular system (hazard index (HI) is 0.55). C1-C5 carbons, in turn, impair the functioning of the respiratory system (HI = 0.44).

An assessment of the risks associated with the cutaneous intake of non-carcinogenic substances revealed that aluminum is the most dangerous element and its hazard coefficient is 2.57*10-5.

The main harmful element entering orally with water is ammonia; its risk value is 0.007.

Thus, the studies performed revealed four main toxic non-carcinogenic elements, which enter the body in various ways. An assessment of their risks showed that they all lie in the range of acceptable values of chronic non-carcinogenic risk.

The results of the survey revealed that the vast majority (70%) of respondents were concerned about the quality of drinking water. The main causes of anxiety when using tap water were statistically reliably established: smell ($p < 0.05$), taste ($p < 0.05$). 56% of respondents complain about the smell of water, and 50% complain about the taste. The study also revealed that 32.51% of respondents use tap water, the rest drink either bottled (29%) or additionally treated water (42%).

The main reasons for the contamination of drinking water are still excessive use of water supply networks, as 42% of water structures need updating, and disinfection of drinking water by chlorination, which also poses a threat to the health of the population of the residential area [10].

The analysis of the survey data found that respondents feel a decrease in the intensity of unpleasant odors in the air only in the daytime. It was statistically reliable that the main causes of complaints are the smell of gas ($p < 0.001$) and chemicals ($p < 0.001$). In percentage terms, 25.2% of respondents report the presence of a gas odor, 15.2% - the smell of chemicals.

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DISCUSSION

It was revealed that the population of residential areas located in close proximity to large petrochemical facilities is under the huge negative impact of emissions of toxic trace elements from enterprises. This means that a high level of heavy metals and gases in the environment contribute to the development of favorable conditions for the onset of pathological processes [8].

Ethylene, ammonia, zinc, aluminum, copper, and C1-C5 carbons have the greatest impact on the study area. The following are descriptions of each pollutant.

Ammonia is classified as a second hazard class. This gas is highly soluble in water, has a sharp, specific smell. The presence of ammonia in water has a detrimental effect on all living organisms. The use of drinking water with a high content of this microelement leads to an increase in blood pressure, leaching of calcium from the body, also causes a decrease in sensitivity to insulin and impaired glucose metabolism.

Copper is a representative of the third hazard class, which has an unpleasant astringent taste, the water in which the trace element is present has a bluish tint. A high concentration of copper in the body causes intoxication, which leads to disruption of the nervous system, kidneys, liver, as well as to perforation of the nasal septum [8].

Aluminum also belongs to the third hazard class. The use of water with an increased concentration of this metal causes a deterioration in the state of the nervous system, the accumulation of aluminum leads to Alzheimer's disease, Parkinson's disease and a number of other neurodegenerative disorders, which means that the element has the ability to accelerate the aging process.

Zinc belongs to the third hazard class. Drinking water with a high concentration of zinc causes after 12-13 hours signs of intoxication, namely fever, bouts of vomiting and pain in the stomach. Chronic effects include erosion of the walls of the stomach, and also an increase in blood cholesterol fractions.

Ethylene belongs to hazard group III. This toxin enters the body through inhaled air. Ethylene has a detrimental irritating effect on the mucous membranes of the body, which over time causes inhibition of the activity of the heart and a decrease in vascular tone. Chronic effects include psycho-emotional and thermoregulation disorders.

A sociological survey revealed the attitude of residents of the study area to the consequences of the operation of the petrochemical enterprise. It was found that a large part of the population is dissatisfied with the deterioration in the quality of not only air and drinking water but also the state of their health in general, and they believe that this is due to the proximity of the plant to the residential area.

SUMMARY

1) The impact of chemicals on the human body is an integral factor if there is a settlement near the petrochemical enterprise. The main pollutants in the study area were ethylene, ammonia, zinc, aluminum, copper, and C1-C5 carbons.
2) The results of the survey showed that the main complaint of the respondents was the presence of unpleasant odors in the air almost around the clock, as well as a specific taste of drinking water.
3) The analysis of the data obtained found that aluminum concentrations are greatest when toxic substances enter the body during skin contact. Its risk value is 2.57*10-5.
4) The most dangerous substances entering the human body through inhaled atmospheric air are ethylene and C1-C5 carbons. Hazard indices were calculated, which made it possible to determine that ethylene is the most dangerous element for the cardiovascular system (HI = 0.55), and C1-C5 carbons negatively affect the respiratory system (HI = 0.44).
5) The calculations of the hazard coefficient revealed that when toxic elements enter the body with water, namely through the skin and drinking water, the level of risk lies in the range of acceptable values (HQ≤1).
6) The calculations of the hazard coefficient revealed that when toxic elements enter the body with inhaled air, the level of risk lies in the range of acceptable values (HQ≤1).

CONCLUSION

The conducted study showed that the population of the considered residential area is daily exposed to various negative impacts from the nearby petrochemical enterprise. An assessment of the impact of such negative factors made it possible to determine that such exposure to many toxic substances leads to the development of various chronic diseases, and the chronic exposure to such harmful substances can make a person disabled.

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CONFLICT OF INTEREST

There is no conflict of interest.

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None.

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