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The Human Health Risk Assessment from Contaminated Air in the Oil-Producing Areas (On the Example of Novoshehminsky Region of the Republic of Tatarstan).

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ABSTRACT

Based on the analysis of the monitoring results the air quality evaluation is provided and the incidence level of oil-producing Novosheshminsky region of the Republic of Tatarstan during the period of 2005-2009. Despite the satisfactory air quality, there is the growth of a number of systemic and autoimmune diseases (blood, blood-forming organs diseases, cancer, the endocrine system diseases) among the district population. The calculated level of non-cancer inhalation risk to public health made 11.0 (extremely high) for children and 2.4 (average) for an adult. The exponential nature of the relationship between the blood diseases, blood-forming organs, autoimmune diseases spread among children and the value of non-cancer risk reflects the presence of the cumulative effect of exposure to low concentrations of pollutants in ambient air on the most vulnerable children of the population.

Keywords: human health risk assessment, air pollution, oil production

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INTRODUCTION

The population health occupies one of the key positions within the a person's system of values and the country as a whole, and is expressed in terms of health indicators, which are the main criteria for the evaluation of people relationship with the environment, complicated by the variety of operating factors and the differentiation of their individual effects on people health.

The most important part of the "human - environment" issue solution is the assessment of the environment-related factors importance affecting the population health, according to the epidemiological studies [1, 2, 3]. At the public health risk evaluation the attention is focused on the atmospheric air condition, which is related with the largest part of all risks in the "environment - health" system [4, 5] because of the massive nature of the impact and direct entry into the body by respiratory or dermal way [6 7].

From major sources of air pollution in the oil-producing areas (flares, production wells, etc..) The products of incomplete combustion of oil and gas, volatile oil, chemical reagents used in the oil extraction and transportation, natural radionuclides are supplied into the environment, including the ambient air from the major sources of air pollution in the oil-producing areas (flares, production wells, etc.) [4]. Even small concentrations of air pollutants may have a synergistic effect on the body at long exposures.

The aim of this work is to measure the level of non-cancer health problem risk among different population groups from prolonged exposure to the air components of air within the oil production conditions.

OBJECT, MATERIALS AND METHODS OF STUDY

Novosheshminsky district of Tatarstan Republic was chosen as the object of study. The territory of this region has been extracting oil since the second half of the 70s, with an annual capacity of up to 1300.0 thousand tons at 12 oil and gas fields.

The data from air monitoring for the period 2005-2009 were used in the settlements of the study area according to the following values: hydrogen sulfide, saturated hydrocarbons C1-C10, benzene, sulfur dioxide, carbon monoxide, nitrogen oxide and dioxide, methane, suspended solids. The assessment of ambient air was performed according to the accepted criteria [8]. The description of the public health and demographic indicators for the period of 2001-2010 was carried out on the basis of the data analysis published in statistical compilations [9]. The integrated assessment of non-cancer health risk from air components was performed as described [10] and expressed in terms of hazard index (HI) for the conditions of several substances simultaneous inhalation.

The analysis and statistical data processing was performed using Microsoft Excel Attestat 13.1 and SPSS Statistics17 in Windows operating system.

RESULTS

The values of pollutants annual average concentrations and the calculated the complex air pollution index (CAPI) [8] in the Novosheshminsky area settlements were ranged at 2.8-4.8 (see Fig. 1), which corresponds to the low level of contamination.

At the evaluation of non-cancer inhalation risk level the population was divided into groups: adults and children. The calculated values of non-cancer risk for the child population ranged from 8 ÷ 14, the average HI value made HI = 11 and is characterized as high and very high. The risk value is varied in the range of 2 ÷ 3 for adults. The average risk made 2.4, which corresponds to an average level. The largest contribution to the total non-carcinogenic risk is made by benzene and hydrogen sulfide.

At the risk level analysis in relation to the people critical organs and systems (Table. 1) we have found that the greatest load as the air pollution result is produced for the respiratory system (HI = 6.0 for children and 1.4 for adults) and the blood-vascular system (HI = 6.6 for children and 1.4 for adults).
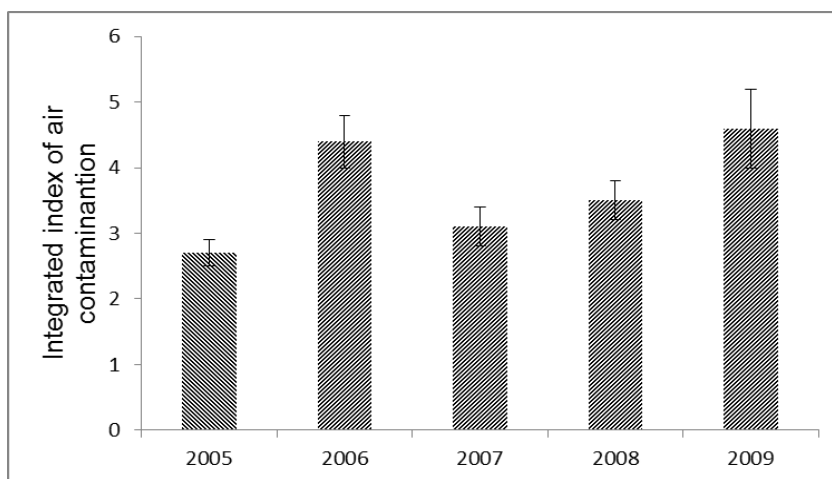
Figure 1. Complex air pollution index dynamics (CAPI) in the Novosheshminsky area settlements

Table 1: Total non-carcinogenic risk for critical organs and the body systems according to population groups for the period 2005-2009.

Population groups	Critical organs / body systems				
	Respiration	CNC	Blood-vascular system	Immune system	Cardiovascular system
Adults	1.4±0,1	1.1±0.2	1.4±0,2	1.0±0,2	1.1±0,2
Children	6.0±0,4	5.0±0,8	6.6±1,0	4.5±0,9	5.0±0,8

The search of causal relationships between population health values and air pollution revealed the relationship between the C_1-C_{10} hydrocarbons content and the children morbidity with blood diseases, blood-forming organs ($R^2 = 0.88$) diseases, the prevalence of the muscle skeletal system diseases among the adult population ($R^2 = 0.66$), as well as between the concentration of sulfur dioxide and the prevalence of the endocrine system diseases among the adult population ($R^2 = 0.98$). A correlation was found between the total value of non-cancer risk and the standardized mortality index from neoplasms ($R^2 = 0.47$).

CONCLUSION

Thus, the results of long-term monitoring in the oil-producing Novosheshminsky region reveal, on the one hand, the air quality stabilization and, on the other hand, - the deterioration of the of children and adult contingent health status by a number of diseases, compared with the average values for the Kama region and the Republic of Tatarstan in general.

The revealed significant quantitative relationship between the content of pollutants in the ambient air and the prevalence of a number of diseases (blood, blood-forming organs, endocrine and muscle skeletal systems), as well as the level of non-cancer inhalation risk reflect the synergetic effect of pollutants low concentrations and the mechanism of their prolonged action on a man's body.

The use of traditional approaches for the evaluation of air quality in the areas of oil production does not predict a negative impact on human health, which makes necessary the use of a methodology for overall risk evaluation for human health from adverse effects of environmental nature.

Summary

- The average non-carcinogenic inhalation risk in the Novosheshminsky area of the Republic of Tatarstan was 11.0 for children (very high) and 2.4 for adult education (average). The largest contribution to the overall non-carcinogenic inhalation risk was made by benzene and hydrogen sulfide. For all the considered groups the critical organs and systems are the respiratory organs (HI =

6.0 and 1.4 for children and adults, respectively), and the circulatory system (HI = 6.6 and 1.4 for children and adults, respectively).

- The influence of the C1-C10 hydrocarbons, hydrogen sulfide and nitrogen oxides concentration was revealed on the incidence of 1 year old children, with blood, blood-forming organs diseases increasing the number of congenital anomalies and chromosomal abnormalities.

- These correlations between the content of pollutants in the ambient air and health and demographic indicators reveal the presence of delayed effect negative impact of low concentrations of substances in the air on the population health in the area with the dominance of the oil extraction business. In order to address the environmental problems in the areas of oil production successfully it is appropriate to include the "health risk" in the value monitoring as the risk reflecting more fully the deferred synergistic effects of the environmental pollution negative impact.

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