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Risk factors in the backbone public health protection complex

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ABSTRACT

The current stage of Russian society development in the conditions of recent socio-economic formation is characterized by a surge of interest and the number of scientific studies devoted to the assessment of environmental factors and the construction of eco-dependent pathology. A region of the Russian Federation with a developed industry was taken as the study area. In particular, indicators of environmental pollution factors, as well as indicators of population morbidity, were studied. The studies were carried out over time for 2013-2018. To assess the risk, the multimedia exposure risk calculating method was used. The hazard index was also evaluated; it characterizes the disturbances of a particular body system. Analysis of the data on the qualitative and quantitative composition of the water basin of the given territory allowed us to conclude that the level of indicators of iron, fluoride, and nitrite compounds, dry residue and water pH practically did not change over time. The concentration of nitrates, total hardness, ammonium salts, BOD_5, sulphate's, and chlorides increased significantly, while dissolved oxygen decreased. Data on the prevalence and primary morbidity among the population indicate that the prevalence and primary incidence rates in the study area are characterized by uneven indicators, which made it possible to rank and establish statistically significant differences in the studied indicators. Data analysis using the methods of parametric and nonparametric statistics made it possible to confirm that the levels of chlorine derivatives, dissolved oxygen, and total hardness significantly affect the formation of the incidence rate of the population in the studied region. The calculated values of carcinogenic risks with the cutaneous intake of cadmium are 2.0×10^{-8}. The values of carcinogenic risks for oral intake of cadmium are 0.3×10^{-6}. It was found that the Deminimis level in the total carcinogenic risk level is 0.6% for the study area.

Keywords: Risk assessment for the population, Morbidity, Environmental factors, Correlation Pleiades, Carcinogenic risk, Hazard index.

INTRODUCTION

The emergence and development of eco-dependent states is the subject of close study by specialists of various profiles: ecologists, medical officers, hygienists, toxicologists, specialists in technosphere safety (Kamaletdinova *et al.* 2018; Akhtyamova *et al.* 2018). Currently, a new scientific direction has emerged, i.e. ecological oncology. According to the modern methodology of carcinogenesis, the induction of the oncological factor occurs under the influence of factors of the internal and external environment (Akhtyamova *et al.* 2018). Environmental factors are modifying factors that allow building model variations in the system of influence of internal and external factors (Artemieva 2015; Criteria for assessing the risk to public health of priority chemicals that pollute the environment. Guidelines 2003). A region of the Russian Federation with a developed industry was taken as the study area

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(Petrova *et al.* 2013). This material presents an analysis of clinical and epidemiological data, taking into account environmental factors over time for 2013-2018.
Methods of parametric and nonparametric statistics were used (Gnahoua Magloire *et al.* 2018; Orha *et al.* 2018; Kudrina *et al.* 2019). It is known that substantial factors in assessing the impact on morbidity and mortality rates of the population are the ways of body exposure to toxicants being factors of the internal and external environment (Fateeva *et al.* 2013). Currently, there is a demand for a methodology for calculating the levels of risks of various origins for the population: carcinogenic, non-carcinogenic, specific, professional, and reproductive (Criteria for assessing the risk to public health of priority chemicals that pollute the environment (Guidelines 2003; Voronin & Fateeva 2015). To assess the risk, the method of calculating the risk under multimedia exposure was used.
The primary school understudies detailed a high predominance of shoulder and neck torment. This examination found that ill-advised sitting situations, just as actual factors, for example, the school furniture, an excessive amount of schoolwork, and trouble in survey the homeroom board, were related with torment. Legitimate intercessions considering the danger factors surveyed in this investigation, are proposed (Gheysvandi *et al.* 2019). Youth stoutness anticipation needs high need. A few danger factors including hereditary factor, undesirable dietary propensities, and actual idleness identified with youth heftiness (Kelishadi & Heidari-Beni 2019). The relationship between BMI, midsection perimeter, and vertebral fracture (VF) danger in ladies was explored (Paik *et al.* 2019). The relationship of predominant vertebral break recognized on vertebral fracture assessment (VFA) pictures in routine practice with episode hip, all non-vertebral, major osteoporotic, and clinical vertebral cracks, utilizing the Manitoba Bone Density information base, were assessed (Schousboe *et al.* 2019). The hazard index, which characterizes the disturbances of a particular body system, was also assessed (http://www.gks.ru). Correlation Pleiades is also constructed that describe the processes in the system of indicators of the external environment and indicators of morbidity and mortality among the population living in the territory of an industrial region.

MATERIALS AND METHODS

This material presents an analysis of clinical and epidemiological data, taking into account environmental factors over time for 2013-2018. Methods of parametric and nonparametric statistics were used. To assess the calculated risk indicators, the managing methodology R2.1.10.1920-04 approved by the Chief State Sanitary Doctor of the Russian Federation on March 5, 2004 was used. To assess the risk of adverse consequences of technogenic environmental pollution in order to ensure public health, the methodology described in the guidelines to evaluate the risk to public health when exposed to chemicals that pollute the environment was applied. The procedure allows expressing the sanitary and ecological ill-being in the territory by comparing the observed or calculated levels of its technogenic pollution with the permissible ones, as well as the expected unfavourable response from the public health. The "risk assessment" methodology is carried out in 4 stages: identification of a harmful factor, exposure assessment, assessment of the exposure-response relationship, risk characterization. The risk identification for carcinogenic substances is based on three descriptors, according to which the substance is described as a carcinogen: is the substance a known or probable carcinogen; it cannot be determined as a carcinogen; it is probably not a carcinogen. Calculation of the total dose of a substance that contaminates different components of the environment and with different routes of exposure is a reasonable approach to risk assessment. During the transition from concentrations of a toxicant in the air and in water to the doses, the “standard parameters” of pulmonary ventilation and water consumption for the adult population were used. 20 m^3 was recommended as an average estimate of the pulmonary ventilation volume per day; recommended drinking water consumption was of 1.9 litres.
The danger coefficient (DC) characterizes the risk to public health. DC is found in terms of the ratio of the estimated human exposure (dose or concentration) to the reference dose or concentration of the pollutant. The hazard index (HI) is calculated as the sum of the danger coefficients of the individual components in the mixture of exposure substances. Risk assessment for exposure to chemicals is carried out in accordance with specific stages. Traditionally, risk assessment involves four steps: detecting priority pollutants; identification; assessment of the dose-response system; risk characteristic. Samples are taken to determine the degree of risk and the working exposure (qualitative and quantitative analysis) by the level and time of contact with pollutants and their ratio with the maximum permissible values are being evaluated” (Criteria for assessing the risk to public health of priority chemicals that pollute the environment. Guidelines 2003; Kudrina *et al.* 2019). Thus, the first step is to identify

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the health hazard; then, either a dose-response estimate is determined, or thresholds, concentrations and uncertainty coefficients are identified depending on carcinogenicity.
The MPC estimate in a residential area is carried out according to the following formula:
R = C / MPC,
Where K is the potential hazard ratio, C is the actual concentration of the polluting element in the air and in drinking water; MPC is the maximum permissible concentration of the element.
Since the inhabitants of the settlement are affected not only by one factor but by many of them, the hazard ratios will be summed up (Criteria for assessing the risk to public health of priority chemicals that pollute the environment. Guidelines 2003; Kudrina *et al.* 2019).

Statistical analyses

After normalizing the data, the statistical analysis of results was performed by means of analysis of variance (ANOVA), on a quantitative dependent variable and independent variables. Analysis of variance was used to test the hypothesis that several means are not the same. In our analyses, we performed several two-way ANOVA for different response variables. In addition to determining that differences between the means exist, several post-hoc LSD tests were considered on factor levels. All statistical analyses were performed using SPSS software (SPSS Inc., Chicago, IL). The significant level was considered as $p < 0.05$.

RESULTS AND DISCUSSION

Changes in the chemical elements of the water composition over time in a region of the Russian Federation with developed industry are analyzed. As a result of the obtained analysis, we can conclude that iron, fluorides, nitrites, and dry residue content and water pH practically did not change over time (p < 0.05] (Kamaletdinova *et al.* 2018; Kudrina *et al.* 2019). Nitrates, total hardness, ammonium salts, BOD_5, sulphates, chlorides and COD, increased, while dissolved oxygen decreased ($p < 0.05$) (Kudrina *et al.* 2019).
Analysis of the data on the incidence of the population revealed the unevenness of the values in the given territory. Over the years, the level of the intensive indicator varied from 1150 to 2503 per 100,000 population ($p < 0.05$).
Correlation analysis made it possible to construct correlation Pleiades in the "pollution-morbidity" system. It was found that a positive correlation coefficient from 0.7-0.9 shows that with an increase in carbon monoxide, the values of incidence rates increase ($p < 0.05$).
A positive correlation coefficient from 0.6-0.8 shows that the incidence rate increases with an increase in carbon monoxide, sulphur dioxide, and suspended solids. A positive correlation coefficient equal to 1 shows that the incidence rate also increases with an increase in carbon monoxide and nitrogen dioxide, and in suspended solids. Water quality has a greater impact on the health of unborn children. A coefficient close to 1 shows that with an increase in the concentration of mercury, aluminium, barium, the incidence increases ($p < 0.05$).
The levels of chlorine and chlorine derivatives, dissolved oxygen, and total hardness significantly affect the formation of the incidence rate of the population in the studied region ($p < 0.05$).
The characteristics of the qualitative and quantitative orders of such indicators as ammonium salts and nitrites, nitrates, and total hardness were studied. The analysis established significant changes in those indicators ($p <0.05$). The concentration of substances in water changes every year. For example, ammonium salts and nitrites decreased by 2016 to a value close to zero (0.003). Nitrates, iron, chlorides and total hardness increased their values. The water pH has remained almost stable over the last three years of observation.
Correlation analysis has been carried out to establish the strength of the relationship between the chemical parameters of the aquatic environment and the population. The power of the relationship between the level of an ammonium salt and the incidence rate was 0.8 ($p < 0.05$). The strength of the relationship between the level of nitrites and incidence rates was 0.9 ($p <0.05$). The strength of the relationship between the level of nitrates and incidence rates was -0.9 ($p < 0.05$). The strength of the relationship between pH and incidence rates was 0.7 ($p <0.05$). The strength of the relationship between the level of iron and its compounds and incidence rates was -0.8 ($p < 0.05$). The strength of the relationship between the level of chlorides and chlorine-containing compounds and incidence rates was 0.2 ($p < 0.05$). The strength of the relationship between the level of general severity and incidence rates was -0.8 ($p < 0.05$). Correlation analysis was carried out to establish the power of the relationship between the chemical indicators of the aquatic environment and mortality. The strength of the relationship between

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the level of ammonium salt and mortality rates was -0.7 ($p < 0.05$). The strength of the relationship between nitrite levels and mortality rates was -0.9 ($p < 0.05$). The strength of the relationship between the level of nitrates and mortality rates was +0.7 ($p < 0.05$). The power of the relationship between pH level and mortality rates was -0.7 ($p < 0.05$). The strength of the relationship between the level of iron and its compounds and mortality rates was +0.6 ($p < 0.05$). The strength of the relationship between the level of chlorides and chlorine-containing compounds and mortality rates was -0.3 ($p < 0.05$). The power of the relationship between the level of general severity and mortality rates was + 0.7 ($p < 0.05$).

The values of carcinogenic risks for the cutaneous intake of cadmium are 2.06×10^{-8}. The values of carcinogenic risks for oral intake of cadmium are 0.39×10^{-6} (Criteria for assessing the risk to public health of priority chemicals that pollute the environment. Guidelines 2003; Kudrina *et al.* 2019).

In this regard, the level of carcinogenic risk transmitted through water bodies was assessed. It was found that the level of Deminimis in the level of the total carcinogenic risk is 0.6% for the study area (Akhtyamova *et al.,* 2018; Kudrina *et al.* 2019: Arekhi *et al*. 2020).

It should also be noted that only an integrated approach to the analysis of the impact of ecology in conjunction with other parameters will make it possible to develop effective management mechanisms to minimize risk factors.

SUMMARY

Intermittent effects characterize 1. Observation of the qualitative and quantitative indicators of a water basin. Compositions of indicators having stable dynamics and variability were revealed.

2. Analysis of the data on the population morbidity has revealed the unevenness of its values in the given territory. Over time, the level of the intensive indicator varied from 1150 to 2503 per 100,000 people.

3. The correlation analysis carried out made it possible to construct correlation groups in the “pollution-morbidity” system. It has been established that a positive correlation coefficient of 0.7-0.9 shows that with an increase in carbon monoxide content, the values of incidence rates increase.

4. A correlation analysis has been carried out to establish the strength of the relationship between the chemical indicators of the aquatic environment and indicators of public health and mortality rates.

5. The strength of the relationship between the ammonium salt level and the incidence rate was 0.8 ($p <0.05$).

6. The strength of the relationship between the level of nitrates and incidence rates was found to be -0.9 ($p <0.05$). The strength of the relationship between the level of chlorides and chlorine-containing compounds and incidence rates was 0.2 ($p < 0.05$). The strength of the relationship between the level of general severity and incidence rates was -0.8 ($p < 0.05$).

7. The strength of the relationship between the level of nitrates and mortality rates was +0.7 ($p < 0.05$). The strength of the relationship between pH level and mortality rates was -0.7 ($p < 0.05$). The strength of the relationship between the level of iron and its compounds and mortality rates was +0.6 ($p < 0.05$).

8. The values of carcinogenic risks for the cutaneous intake of cadmium are 2.06×10^{-8}.

8. The values of carcinogenic risks for oral intake of cadmium are 0.39×10^{-6}.

9. It was found that the Deminimis value in the level of the total carcinogenic risk is 0.6% for the studied area.

10. An integrated approach to the analysis of the impact of ecology, in combination with other parameters, will allow developing effective management mechanisms to minimize risk factors.

CONCLUSIONS

As a result of the study, reliable data were obtained on the impact of technospheric environmental factors on the biomedical indicators of the population living in the territory with a developed industry. Correlation analysis made it possible to construct correlation Pleiades in the "pollution-morbidity" system.

It was found that a positive correlation coefficient from 0.7-0.9 shows that with an increase in carbon monoxide, the incidence rate values significantly increase. Observation of the qualitative and quantitative indicators of a water basin is characterized by an intermittent effect, which must be taken into account when constructing models of the interactions between a damaging element and the level of response.These studies make it possible to develop limiting indicators when assessing environmental safety.

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چکیده

مرحله‌ی فعلی توسعه‌ی جامعه‌ی روسیه در شرایط اقتصادی اجتماعی فعلی، با افزایش علاقه به مطالعات علمی در خصوص ارزیابی عوامل زیست‌محیطی و بیماری‌های محیطی همراه است. منطقه‌ی فدراسیون روسیه با یک صنعت پیشرفته به‌عنوان منطقه‌ی مورد مطالعه در نظر گرفته شد. به طور خاص، شاخص‌های عوامل آلودگی محیط‌زیست، و همچنین شاخص‌های ابتلا به بیماری در جمعیت مورد مطالعه قرار گرفت. مطالعات به مرور زمان ۲۰۱۳- ۲۰۱۸ انجام شدند. برای ارزیابی خطر، روش محاسبه‌ی مخاطرات چند جانبه استفاده شد. شاخص خطر نیز محاسبه شده است که در آن آشفتگی و اختلال در یک اکوسیستم خاص بررسی می‌شود. تجزیه و تحلیل داده‌های مربوط به ترکیب کمی و کیفی منابع آب، نشان داد که سطح شاخص‌های آهن، فلورید و ترکیبات نیتریت، بقایای خشک و pH آب به مرور زمان تغییر نکرد. غلظت نیترات‌ها، سختی کل، نمک‌های آمونیوم، BOD_5، سولفات و کلریدها به طور قابل توجهی افزایش یافت، در حالی که اکسیژن محلول کاهش یافت. داده‌های مربوط به شیوع و بیماریهای اصلی در میان جمعیت نشان داد که نرخ شیوع بیماری در منطقه با شاخص‌های غیر یکنواخت و متغیر مشخص می‌شود و لذا امکان رتبه بندی و تعیین تفاوت‌های معنی‌دار از نظر آماری میان شاخص‌ها وجود دارد. این به دلیل اثر عوامل مختلف است. دسترسی به مراقبت‌های پزشکی، سطح فرهنگی جامع، تعداد پزشکان و کادر درمان، استاندارد زندگی جمعیت. تجزیه و تحلیل داده‌ها با استفاده از روش‌های آماری پارامتریک و غیرپارامتری نشان داد که سطح مشتقات کلر، اکسیژن محلول و سختی کل به طور قابل توجهی شیوع بیماری در جمعیت در منطقه مورد مطالعه تأثیر دارد. مقادیر محاسبه شده‌ی ریسک سرطان زایی با جذب پوستی کادمیوم 2.0×10^{-8}است. مقادیر خطرات سرطان زایی برای مصرف خوراکی کادمیوم 0.3×10^{-6}. است. مشخص شد که سطح حداقل سرطان زایی در منطقه‌ی مورد مطالعه ۰/۶ ٪ است.

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