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Assessment of Health Risks of the Child Population in the Consumption of Drinking Water, Taking Into Account Secondary Pollution on the Example of Kazan.

Tunakova J[1], Galimova A[1]*, Fajzullin R[2], and Valiev V[3].

[1]Kazan National Research Technical University named after A.N.Tupolev - KAI (KNRTU-KAI), Russian Federation, 420111, Kazan.
[2]Kazan Federal University, Russian Federation, 420008, Kazan.
[3]Institute of Ecology and Mineral Sciences Academy of the Republic of Tatarstan, Russian Federation, 420087, Kazan.

ABSTRACT

Presents approaches and results of health risk assessment of the child population of Kazan from the consumption of drinking water on the basis of regulated procedures in the Russian Federation, based on a study carried out by cation-anion composition of drinking water at the final point of consumption.
Keywords: risk to health, drinking water, secondary pollution, the reference dose, carcinogenic potential.

Corresponding author

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INTRODUCTION

The quality of tap water supplied to consumers in the city of Kazan, must meet the requirements must comply with sanitary regulations and standards adopted in the Russian Federation [1]. However, do not exceed existing quality standards does not guarantee the absence of harmful harm to human health, especially the sensitive groups. Much more than a reasoned opinion about the danger to health or safety of the child population the consumption of tap water, can assess the integral indicator of the quality of drinking water, which is determined on the basis of the approved calculation methods in the Russian Federation, the relevant regulations of the WHO [2,3].

EXPERIMENTAL

To assess the quality of supplied drinking water to the consumers in the city of Kazan was conducted sampling in homes and apartments, located in the service areas of children's clinics throughout the city of Kazan.

To determine the drinking water used metal cations by atomic absorption spectrometry (AAS), which is one of the most accurate, selective, and rapid methods. AAS method was conducted six present definition of metal cations entering surface water discharges from enterprises of Kazan and is not systematically monitored on intakes for all service areas of children's clinics: Pb, Cu, Zn, Cr, Sr, Fe, for three years (2012-2014 years).

RESULTS AND DISCUSSION

To analyze the composition of the anionic water was chosen method of ion chromatography, with similar advantages. By ion chromatography identified six anions present in drinking water in all service areas of children's polyclinics. It was determined the content of NO_2^-, NO_3^-, SO_4^{2-}, F^-, Cl^-, PO_4^{3-} anions in water samples. A total of more than 1,200 definitions of ion content, the results of which are shown in Table 1. Statistical analysis of the results carried out on a computer using the Statistical Package «STATISTICA v.6.0».

Table 1: Results of certain ions in tap water at service areas clinics

areas	Sr	Cu	Pb	Zn	Cr	Fe	NO_2^-	NO_3^-	SO_4^{2-}	F^-	Cl^-	PO_4^{3-}
1	0,105± 0,009	0,0011± 0,0001	0,012± 0,0006	0,015± 0,0015	0,0006± 0,0002	0,090± 0,011	0,0032± 0,0004	0,81± 0,06	85± 9	0,35± 0,015	24,0± 1,39	0,04± 0,0044
2	0,163± 0,031	0,0017± 0,0003	0,015± 0,003	0,035± 0,0089	0,0045± 0,0021	0,084± 0,019	0,004± 0,0006	1,01± 0,08	96± 11	0,24± 0,012	22,8± 1,73	0,05± 0,0055
3	0,223± 0,023	0,0024± 0,0007	0,012± 0,002	0,019± 0,0014	0,0021± 0,0002	0,109± 0,0007	0,0036± 0,0005	0,92± 0,07	87± 10	0,22± 0,011	24,4± 1,57	0,045± 0,0055
4	0,110± 0,007	0,0015± 0,0015	0,013± 0,0012	0,017± 0,0016	0,0035± 0,0014	0,079± 0,006	0,0034± 0,0005	1,03± 0,08	86± 9	0,24± 0,015	22,0± 1,76	0,051± 0,0044
5	0,337± 0,011	0,0019± 0,0003	0,014± 0,002	0,025± 0,004	0,0021± 0,0005	0,095± 0,010	0,0038± 0,0005	0,86± 0,07	90± 10	0,22± 0,013	25,7± 1,48	0,045± 0,0052
6	0,209± 0,007	0,0022± 0,0003	0,012± 0,0009	0,019± 0,0019	0,0021± 0,0002	0,107± 0,0046	0,004± 0,0008	0,97± 0,09	84± 9	0,24± 0,011	22,2± 1,67	0,049± 0,0043
7	0,112± 0,008	0,0022± 0,0027	0,013± 0,0013	0,016± 0,0013	0,0008± 0,0002	0,079± 0,0018	0,0036± 0,0006	0,92± 0,07	88± 10	0,24± 0,014	24,1± 1,57	0,043± 0,0047
8	0,453± 0,215	0,0018± 0,0003	0,018± 0,0023	0,018± 0,0023	0,0047± 0,0030	0,063± 0,017	0,0032± 0,0004	0,81± 0,08	83,4± 9,2	0,36± 0,011	25,4± 1,39	0,051± 0,0058
9	0,118± 0,005	0,0013± 0,0004	0,012± 0,0003	0,031± 0,004	0,0012± 0,0002	0,088± 0,0058	0,004± 0,0005	1,01± 0,07	86,1± 9,5	0,23± 0,018	24,1± 1,71	0,045± 0,0055
10	0,105± 0,028	0,0015± 0,0002	0,016± 0,0042	0,017± 0,0035	0,0026± 0,0016	0,099± 0,018	0,0036± 0,0007	0,92± 0,07	87,2± 9,6	0,24± 0,011	24,2± 1,58	0,048± 0,0052
11	0,170± 0,017	0,0016± 0,0004	0,013± 0,0022	0,030± 0,0079	0,0043± 0,0018	0,084± 0,019	0,004± 0,0004	1,05± 0,08	83,4± 9,2	0,24± 0,013	21,8± 1,81	0,043± 0,0055

The analysis found that the content of metal cations in different areas of research varies widely, due to both belonging to the underground water sources and surface water withdrawals, and varying degrees of secondary pollution of drinking water. Concentration of anions at various zones study had no statistically significant differences. Evaluation of cation-anion composition of tap water in the apartments of the city's population has shown that in the majority of water sampling points meets the requirements [1]. But, as mentioned earlier, a reasoned opinion on the safety of drinking water can provide an integrated assessment of water quality from the perspective of the theory of risk.

Evaluation of non-carcinogenic health risk was based on the method described in the manual [2], apply the value of the reference doses, which are the individual characteristics of each substance (the threshold calculation model).

We have calculated the dose for chronic ingestion of analyzed ions in drinking water for the child population of the selected areas of study in the territory of Kazan. Daily doses were determined by taking into account water consumption in children depending on the age and duration of exposure, in accordance with domestic and foreign approaches [2-4]. At the stage of the exposure assessment determined that the calculated dose for chronic ingestion of analyzed ions with drinking water do not exceed the reference dose (RFD) for the child population. The hazard quantity (HQ) is determined by comparing the amount of potential daily dose of a substance behave in a certain way, and the level of safe exposure under the same route of exposure. If the calculated hazard quantity (HQ) of no greater than one, the chances of having a harmful effect in the daily intake of the substance in their lifetime, and is considered to be negligible influence is characterized as acceptable.

Hazard Index (HI), which is characteristic of non-carcinogenic effects of risk when combined and complex impact on the condition of simultaneous arrival of several substances in the same way. HI is calculated as the sum of the hazard quantity for individual components of the mixture forcing agents. When you receive a comprehensive chemical in the human body from the environment in several ways at the same time measure of risk is the total hazard index. Analysis of the additive unidirectional action of the ions determined in drinking water in the organs showed that chronic exposure hazard index (THI_{wo}) does not exceed the permissible level for children's population consuming water in selected areas of research.

Next it was evaluated using non-carcinogenic risk-threshold model for the standard methodological recommendations [3], in which the obtained value indicates the probability of the risk of abnormalities at given levels of radiation exposure (individual risk). Estimation of the total non-carcinogenic risk is carried out by multiplying the probabilities. The calculation results showed that the risk of non-carcinogenic and water consumption of water to the established content of cations and anions, designed by no threshold does not exceed the acceptable values in any area.

Table 2: Values of the integral index of risk areas of research

area	$R^{Pb(II)}_{carcinogenic}$	$R^{Cr(VI)}_{carcinogenic}$	$R^{n+}_{carcinogenic}$	excess of risk
1	0,000016	0,000009	0,000025	2,5
2	0,000023	0,000076	0,000099	9,9
3	0,000018	0,000026	0,000044	4,4
4	0,000018	0,000056	0,000075	7,5
5	0,000021	0,000030	0,000051	5,1
6	0,000017	0,000026	0,000043	4,3
7	0,000018	0,000012	0,000030	3,0
8	0,000026	0,000089	0,000115	11,5
9	0,000016	0,000016	0,000032	3,2
10	0,000026	0,000048	0,000074	7,4
11	0,000020	0,000070	0,000090	9,0

$R^{n+}_{carcinogenic}$ - the total cancer risk consumption analyzed cations in drinking water for areas of research.

Next, we calculated the carcinogenic risk of children's health from the consumption of drinking water. Of all analyzed ions possess carcinogenic potential of lead and chromium cations, so the calculation was made for the carcinogenic risk of these ions, and in respect of chromium ions into account its transition to the

hexavalent state at the set slightly alkaline reaction of the medium water water (pH = 7,3 ± 2). The calculation results are shown in Table 2. In accordance with the recommendations of the WHO in relation to the quality of drinking water as the acceptable cancer risk should choose the value of 0.00001. As shown in Table 2, the total carcinogenic risk to health from drinking tap water exceeds the upper limit of the permissible individual carcinogenic risk in all areas.

It should be noted that the results of risk assessment children's health from the use of drinking water established by the ionic composition exceed the upper limit of the permissible individual carcinogenic risk in all areas of 2.5-11.5 times. However the most carcinogenic risk in drinking water is subject to the child population in zones 2 and 8. The main source of the danger of drinking water are ions of lead and chromium, are carcinogenic potential, which should be considered when choosing a device for water purification. Approaches for evaluating the quality and purification of drinking water in more detail in earlier publications the authors [6-8].

According to [5] while the carcinogenic risk to health by the consumption of drinking water are likely following health problems: eye diseases; diseases of skin and subcutaneous tissue; diseases of the musculoskeletal system; diseases of the blood forming organs and certain disorders involving the immune mechanism; diseases of the genitourinary system; nervous system diseases, diseases of the digestive system; diseases of the endocrine system; congenital malformations deformations and chromosomal abnormalities, tumors. Applying risk-based approach is necessary for the implementation of the federal state sanitary-epidemiological control (supervision). The class of potential danger coming to consumers of drinking water requires full scope of laboratory and instrumental researches ionic composition of drinking water, especially ion content of lead and chromium, are not systematically monitored in the waters of prepared intakes Kazan.

CONCLUSION

According to WHO guidelines [4] focused on health approaches to assessing the quality of applicants to the public drinking water possible to determine the "standard" for structures providing water supply for the development of water safety plans and verify their successful implementation.

Health risk assessment enables the development of more flexible and adequate to address this situation, recommendations for the protection of the child population in the use of drinking water of poor quality.

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