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THE WATER HARDNESS AND ITS RELATIONSHIPS WITH THE LEVEL OF TUMOR MARKERS AMONG THE INHABITANTS OF YAKUTIA

DOI 10.25789/YMJ.2018.63.11

ABSTRACT

A total of 675 residents aged 18 to 79 years living in 6 different regions of the Republic of Sakha (Yakutia), 461 men and 214 women were examined. The purpose of the study was to assess the extent of the relationship between the level of tumor markers, depending on the rigidity of used water. The concentration of tumor markers in blood serum was determined by the method of enzyme immunoassay. 54.1% of all surveyed people use unpurified water for drinking purposes. Of the six surveyed areas in only three (Namsky District, Verkhnekolymsky District, Aldansky District), the water hardness level corresponded to the norm. The correlation analysis found significant direct correlation between the level of tumor markers and water hardness: AFP (r = 0.134, p = 0.000), CEA (r = 0.211, p = 0.000), PSA (r = 0.360, p = 0.000) and CA-125 (r = 0.290, p = 0.000).

Keywords: water hardness, tumor markers, Yakutia.

Introduction

Yakutia has huge reserves of water resources, on it's territory there are more than 700 thousand large and small rivers, which is about 30% of all rivers in Russia. On the territory there are about 825 thousand lakes with an area of more than 1 ha, which is more than 40% of Russia's lakes. [1]. The surface waters of Yakutia belong to moderately polluted waters, although a large number of toxic elements are emitted in sewage. Large-scale polluters of surface waters are cities, large settlements located along the river basins. High levels of pollution are facilitated by: - the presence of permafrost, which does not allow seepage to surface water, which leads to contaminated water spilling over the surface; - Due to prolonged winter, short summer, biological treatment of polluted water is slow. If in the European territory of Russia contaminated water is cleared through 200-300 km, then in the rivers of Yakutia it is not cleared up to 1500 km [3]. Yakutia, according to the incidence rate of some nosological forms of malignant tumors, belongs to the regions that are among the leaders of not only Russia but also in the world. In terms of the incidence of malignant tumors of the esophagus, liver and lung, both in men and women, the republic is among the territories with the highest rates among the remaining regions of the Russian Federation [2].

Water objects on the territory of the Republic of Sakha (Yakutia) are used for drinking and household water supply of the population, electricity generation in gold mining, diamonds, non-metallic building materials, wastewater discharge and other purposes. The main consumers of water are industry (diamond and gold mining, mining of precious metals, electric power and housing and communal services) [6].

In the conditions of ecological trouble, the immune, endocrine and central nervous systems react before other systems, causing a wide range of functional disorders. Among oncological diseases, diseases of lung tissue, skin and digestive organs are characterized by special eco-dependency, since there is direct contact with environmental factors - air and water [4].

According to WHO, 85% of all diseases in the world are associated with water pollution, because in such water contains more than 13000 toxic elements, including chlorine and its organic compounds, salts of heavy metals, nitrates, pesticides, which leads to the development of serious human diseases, including diseases of the cardiovascular system, malignant diseases. In this regard, the study of the relationship between the quality of water used and the health status of the population, in particular the level of specific markers that assess the risk of cancer, is of interest. The purpose of the study was to assess the degree of relationship between the level of tumor markers and the contamination of water used.

Methods and materials of the study

A total of 675 residents aged 18 to 79 years living in 6 different regions of the Republic of Sakha (Yakutia), 461 men and 214 women were examined. The national composition of the surveyed persons was represented by 246 Yakuts, 194 indigenous small-numbered peoples of the North (Evenki, Evens and Dolgans), 236 people (Russians, Tatars, etc.) .The environmental impact is significantly influenced by anthropogenic pressures on the territory, including the population and different types of technogenic pollution. The regions we surveyed were ranked according to the stress factor index (SFI) (E.I. Burtseva, 2006), which reflected a comprehensive assessment of the state of the environment surrounding environmental impacts (including mountain mass extracted from the earth's interior, pollutant emissions in atmosphere, discharge of polluting wastewater), Gorny District refers to areas with low load (I); Anabarsky District - with reduced load (II); Namsky District - with medium load (III), Verkhnekolymsky District - with increased load (IV); Aldansky and Lensky Districts - with a high load (VI, V) (Table 1).

The surveyed areas of Yakutia belong to various zones of Yakutia, according to climatic and anthropogenic pressures. The Gorny and Namsky Districts belong to the Central zone of Yakutia, Anabarsky and Verkhnekolymsky Districts - to the Arctic zone, Lensky and Aldansky Districts - to the Southern industrial zone.

Blood for laboratory tests was taken from the ulnar vein in the morning on an empty stomach. To identify the risk groups for oncopathological conditions, we were determined of concentration of tumor markers by the enzyme immunoassay method: alfa-fetoprotein (AFP), cancer embryonic antigen (CEA), for men prostate-specific antigen (PSA), for women CA-125 in serum using test kits of the firm « Vector-Best «(Novosibirsk, Russia). Data of the chemical composition of water, taken from ponds used by residents for drinking purposes (Matta River - Magarass

Table 1

Characteristics of the surveyed population by age and sex

Locality, District of the Republic of Sakha (Yakutia)	SFI (Burtseva E.I., 2006)	Total surveyed	Men / women	Average age
v. Magarass, Gorny District	low load	54	10 / 44	42,00 ± 10,45
v. Modut, Namsky Ditrict	medium load	119	41 / 78	45,82 ± 11,65
v. Saskylakh, Anabarsky District	reduced load	135	37 / 98	48,26 ± 13,33
v. Nelemnoe, Verkhnekolymsky District	increased load	138	50 / 88	44,45 ± 13,6
v. Vitim, Lensky District	high load	65	11 / 54	46,52 ± 14,67
v. Tommot, Aldansky District	high load	164	65 / 99	44,23±11,40

village, Gorny District; in the area of water intake of the Lena River - Modut village, Namsky District; SPNT «The Yasachnaya basin» - Nelemnoe village, Verkhnekolymsky District; Peleduy River - Vitim village, Lensky District; Aldan River - Tommot village, Aldansky District) have been provided by the Office of the Hydrometeorological Service of the RS (Y).

The study was approved by the decision of the Local Ethical Committee of the FSBSI «YSC of the CMP» and was carried out with the informed consent of the test subjects in accordance with the ethical norms of the Helsinki Declaration (2000). Statistical processing of data was carried out using the SPSS Statistics 19 software package. The normality of the distribution of quantitative indicators was verified using the Kolmogorov-Smirnov test. Standard methods of variational statistics were used: calculation of average values, standard deviation. The data in the table are presented in the form M ± σ, where M - is the mean, σ - is the standard deviation. To study the relationships between the variables, a pair correlation procedure was used using the Spearman's test (for variables measured in the rank scale), where r - is the correlation coefficient, and p - is the significance of the result. When comparing the quantitative indices of the groups, the significance of the differences was assessed using the Student's t-test for the normal distribution and the Mann-Whitney test for the abnormal distribution. The results were considered to be statistically significant with the values of the achieved significance level p<0.05.

Results and discussion

The survey data (response - 94.2%) were analyzed, in which the respondent asked the question: «Which water do you drink most often for drinking purposes?» Chose 4 options for response (1 - water from harvested ice, 2 - packaged, 3 - filtered , 4 - unpurified). The analysis of the survey data showed a different nature of the answers that have common trends depending on the place of residence. Thus, 54.1% of all surveyed people drink unpurified water for drinking purposes; 23.6% - melt water, 20.1% - filtered water and only 2.3% - packaged water.

Residents of the Arctic zone (Verkhnekolymsky and Anabarsky Districts) consume mostly unpurified water (91.2% and 59.5%, respectively). The Central regions (Namsky and Gorny Districts), where there is no centralized water supply, drink melt water from the lakes and rivers (58% and 92.6%, respectively). In industrial regions of Yakutia (Aldansky and Lensky Districts), the proportion of people who use packaged or filtered water is much higher than in other regions, which indirectly indicates a low quality of water. However, in the Aldansky District, the proportion of people using unpurified water is predominant (61.5%).

The water hardness of these settlements indicates significant differences: very soft water is noted in Gorny (0.8 mmol / L) and Anabarsky Districts (0.9 mmol / L). In Lensky District the water hardness value is the highest (7.86 mmol / L) , almost unfit water for consumption for drinking purposes (up to 7 mmol / L). Of the six surveyed districts, only three (Namsky, Verkhnekolymsky, Aldansky) had a water hardness level of 1.5 mmol / L to 7 mmol / L (Figure 2).

Undoubtedly, a high index of water hardness in the Peleduy River is caused by a high concentration of chlorides (1.58 * TLV), sulfates (2.8 * TLV), sodium (2.4 * TLV), copper (1.6 * TLV) and manganese (2.5 * TLV) and strontium belonging to the 3rd danger class exceeds the TLV by 3.9 times. It should be noted that the concentration of calcium and magnesium in the Peleduy River was the highest in comparison with other regions, although the upper limits of the TLV were not exceeded.\

The conducted correlation analysis of the chemical substances, depending on the water hardness, established strong positive correlation links on the concentration of chlorides (r = 0.969, p = 0.000), calcium (r = 0.889, p = 0.000), sulfates (r = 0.848, p = 0.000) and magnesium (r = 0.860, p = 0.000), negative correlations from the iron concentration (r = - 0.774; p = 0.000) of lead (r = -0.562; p = 0.000).

To determine the significant relationships between water hardness and blood parameters, ranking was carried out: 1 group included residents of areas with soft water (Gorny District, n = 189), 2 - with normal hardness of water (Namsky, Anabarsky, Verkhnekolymsky and Aldansky, n = 421) , 3 - with hard water (Lensky district, n = 65). The conducted correlation analysis established significant direct correlation links of the tumor marker level with increasing water hardness: AFP (r = 0.134; p = 0.000); CEA (r = 0.211; p = 0.000) , PSA (r = 0.360, p = 0.000) and

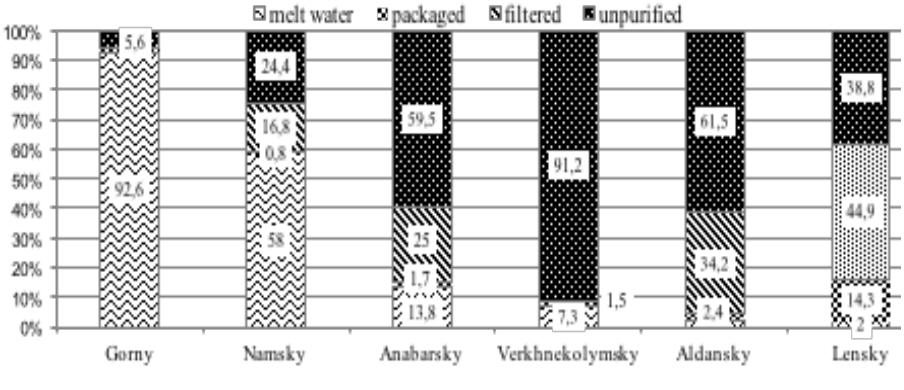

Fig. 1. The distribution of the surveyed persons, depending on the type of water consumed for drinking purposes.

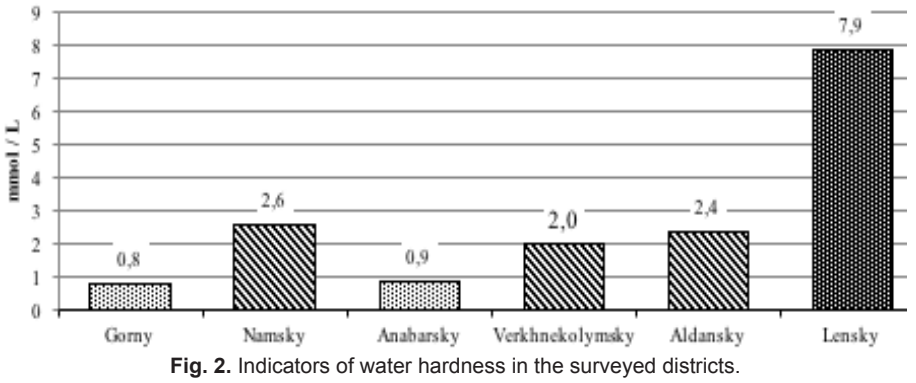

Fig. 2. Indicators of water hardness in the surveyed districts.

Table 2

The level of tumor markers in residents, depending on the hardness of water

Tumor markers	1 group (soft water)	2 group (normal water)	3 group (hard water)	P
Alpha-fetoprotein (AFP);	6,65±0,34	7,41±0,16	7,63±0,35	$0{,}045^{1,2}$ $0{,}047^{1,3}$
0-10 pg/ml	2,26±0,10	3,12±0,08	3,77±0,12	$0{,}000^{1,2}$ $0{,}000^{1,3}$ $0{,}003^{2,3}$
Cancer embryonic antigen (CEA); 0-5 pg/ml	1,07±0,09	2,25±0,11	2,27±0,50	$0{,}000^{1,2}$ $0{,}039^{1,3}$
Prostate-specific antigen (PSA); 0,3-4,0 pg/ml	14,14±1,66	25,2±0,73	15,71±0,95	$0{,}000^{1,2}$ $0{,}000^{2,3}$
CA-125;0-35 pg/ml				

CA-125 (r = 0.290, p = 0.000) (Table 2).

Tumor markers expressed by low-differentiated cells are not only associated with a tumor, but also with the presence of chemical, toxic environmental factors. CEA serves as a sign of malignant growth of any nature and localization and is completely nonspecific. CEA is a nonspecific marker for any type of tumor and reflects the general carcinogenic background of the organism. With regular use of hard water, the risk of various diseases of the internal organs increases, in the first place, of the liver and kidneys [5].

Thus, the results obtained by us indicate that the residents who drink water contaminated with chemicals for drinking purposes are at increased risk of cancer.

Conclusions

1. 54.1% of all the surveyed people drink unpurified water for drinking purposes; 23.6% - melt water, 20.1% - filtered water and only 2.3% - packaged water.

2. The water hardness of these districts indicates significant differences: very soft water is noted in the Gorny and Anabarsky Districts. In Lensky Districts, the value of water hardness is the highest, almost unfit for consumption for drinking purposes. Of the six surveyed districts in only three (Namsky, Verkhnekolymsky, Aldansky), the level of water hardness corresponded to the norm.

3. The correlation analysis found significant direct correlation of the level of tumor markers with increasing water hardness: AFP (r = 0.134, p = 0.000), CEA (r = 0.211, p = 0.000), PSA (r = 0.360, p = 0.000) and CA- 125 (r = 0.290, p = 0.000).

References

1. Burtseva Ye.I. Geoekologicheskiye aspekty razvitiya Yakutii [Geoecological aspects of the development of Yakutia]. Novosibirsk: Nauka, 2006, 269p.
2. Ivanov P.M., Tomskiy M.I., Kipriyanova N.S. Zlokachestvennyye novoobrazovaniya v Yakutii v nachale tret'yego tysyacheletiya [Malignant neoplasms in Yakutia at the beginning of the third millennium]. Yakutsk: «Smik-Master. Poligrafiya», 2012, 168 p.
3. Lapteva N.I. Ekologicheskoye sostoyaniye poverkhnostnykh vod:ucheb, posobiye [Ecological state of surface waters: textbooks, manual]. Moscow: Akademiya, 2001, p.20-25.
4. Mikheyeva G.Kh., Gataulllin I.G., Biktemirova R.G. Zagryazneniye okruzhayushchey sredy faktor riska formirovaniya zabolevayemosti onkologicheskoy patologiyey v Ul'yanovskoy oblasti [Pollution of the environment is a risk factor for the formation of the incidence of oncological pathology in the Ulyanovsk region]. Tyumenskiy meditsinskiy zhurnal [Tyumen medical journal], 2012, No.4, p. 20-22.
5. Turovskiy B.V., Inyukina T.A. Opasnyye i vrednyye primesi prirodnykh i pit'yevykh vod. [Dangerous and harmful impurities of natural and drinking waters] Politematicheskiy setevoy elektronnyy nauchnyy zhurnal Kubanskogo gosudarstvennogo agrarnogo universitet [The Political Network Electronic Scientific Journal of the Kuban State Agrarian University], 2014, No 102, p. 432-445.
6. Ammosova M.N. et.al. Ekologicheskaya situatsiya v zolotodobyvayushchey promyshlennosti Respubliki Sakha (Yakutiya) [Ecological situation in the gold mining industry of the Republic of Sakha (Yakutia)] Fundamental'nyye i prikladnyye issledovaniya: problemy i rezul'taty [Fundamental and applied research: problems and results]. 2014, No.15, p.21-25.

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