Journal of International Scientific Publications: Ecology and Safety

Volume 8, ISSN 1314-7234 (Online), Published at: http://www.scientific-publications.net

DRINKING WATER QUALITY OF JEWISH AUTONOMOUS REGION IN CONTENT EXCESS AND DEFICIENCY AND ITS REFLECTION ON PUBLIC HEALTH

[1]Dina G. Bondareva, [2]Olga V. Surits, [1,3,4]Nadezhda K. Khristoforova, [1]Elena O. Klinskaya

[1]Shalom Aleichem's Amur State University, department of ecology and biology,

679016, Birobijan, Jewish autonomous region, Russia

[2]FBIH «Center Hygiene and Epidemiology of JAR», 679016, Birobijan,

Jewish autonomous region, Russia

[3]Far Eastern Federal University, department of ecology, 690039, Vladivostok, Russia

[4]Pacific Institute of Geography FEB RAS, 690041, Vladivostok, Russia

Abstract

Analyzed the levels of fluoride, iron, manganese and hardness in drinking water for the Jewish Autonomous Region 2008-2012. Revealed low levels of stiffness and F, do not reach their optimum levels. Set high content of Fe and Mn in drinking water field. Noted that only in some cases concentrations of Fe and Mn correspond to the MAC. Using factor analysis found that the priority biogeochemical factors affecting the disease of the musculoskeletal system and the circulatory system in the JAR are stiffness and fluoride content in drinking water.

Key words: *drinking water, fluoride, rigidity, iron, manganese, factor analysis, disease of the musculoskeletal system, circulatory system, diseases of the skin and subcutaneous tissue*

1. INTRODUCTION

At the present stage of health development is generally accepted that environmental factors are the cause of some diseases. These include endemic diseases associated with excess or deficiency of exposure of certain micro or macro elements. Consequently, the environment of the region of residence with specific geochemical conditions defines features of health of the population [1, 2, 3].

The Jewish Autonomous Region (JAR) is the small and quite compact territory, slightly elongated in an east direction. It is a kind of natural formation related to biogeochemical provinces with a deficit in the environment of such elements, as Ca, Mg, F, I, Se, Co, Cu and excess of Fe and Mn [4]. Undoubtedly, the deficiency or excess of some elements or their combination may affect the health status of autonomy. And this can most clearly manifested in the use of drinking water.

It is known that certain amounts of fluoride required for the optimal structure of bones and teeth [5, 6, 7, 8], for better and well-timed mineralization of bones and teeth in the early years of life and to preserve bone mineralization in older age [9, 10].

Calcium possesses high physiological activity, carries out multiple functions in an organism such as bone formation, mineralization of teeth, the regulation of intracellular processes, the regulation of processes of nerve conduction and muscle contraction, keeping a stable cardiac activity. Normal level of magnesium in an organism is necessary for ensuring many vital processes. Magnesium strengthens the immune system, possesses antiarrhythmic activity [2]. The rigidity of water testifies to the low content in it of calcium and magnesium.

Iron gets into the human body with food and water. It is believed that the recommended daily Fe norm is 10-20mg/dm3. Excess of iron can contribute to its accumulation in the body that causes physical weakness, weight loss, and frequent illness [2]. Prolonged drinking of water with Fe content more than 1.0 mg/dm^3 may cause dryness, flaking and skin irritation. The water consumption with concentration of more than 30 mg/dm^3 for 15-20 years may cause to diseases of blood and siderosis [11].

There is usually manganese in water with the dissolved iron. The content of manganese in drinking water above the MPC (0.1 mg/dm^3) leads to diseases of the skeleton accompanied by fatigue, retardation, a depression, a restraint of movements, and in far come cases – violation of the CNS functions. Adequate level of average daily consumption of manganese – 2 mg, the top permissible consumption level – 11 mg/day [2].

Thus, long-term person residence in the territory with a low content of fluoride, calcium, magnesium in drinking water and high of Fe and Mn can lead to serious defections in the body.

2. STUDY AREA. MATERIALS AND METHODS

Jewish Autonomous Region is located in the northeastern part of the Eurasian continent, in the south part of the Russian Far East between 47° and 49° north latitude and east longitude between 130°-135°, between Amur river and Malohingansky mountains, referring to the Far Eastern territory of the Russian Federation. In the west autonomy borders with the Amur region, in the north – with the Khabarovsk territory, in the south of the Amur River border area match with the state border of Russia and China (Fig. 1a). It covers an area of 36.3 thousand km^2 (3626.6 hectares). Population is 171.5 thousand people (data of the Territorial Department of the Federal State Statistics Service of the JAR, 2013). It is divided into 6 administrative areas, including Birobidzhan city as an administrative center.

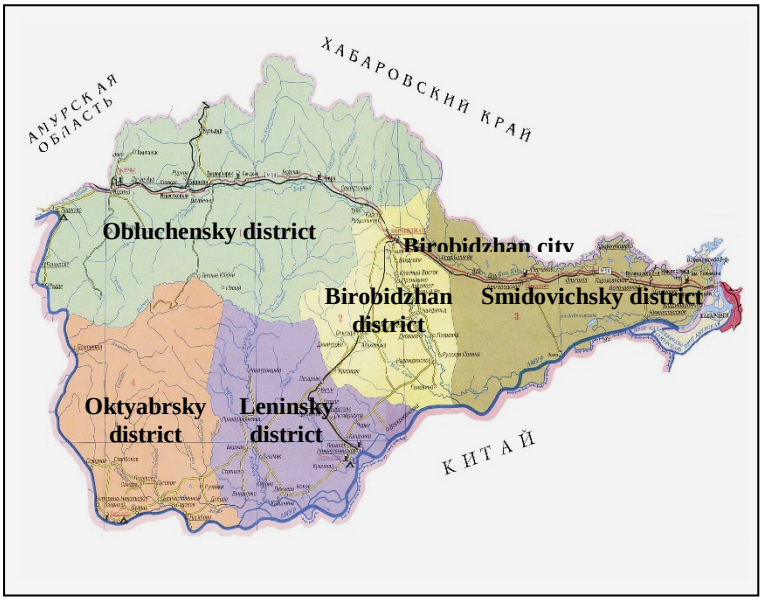


Fig. 1 a. Schematic map of administrative-territorial division of the Jewish Autonomous Region

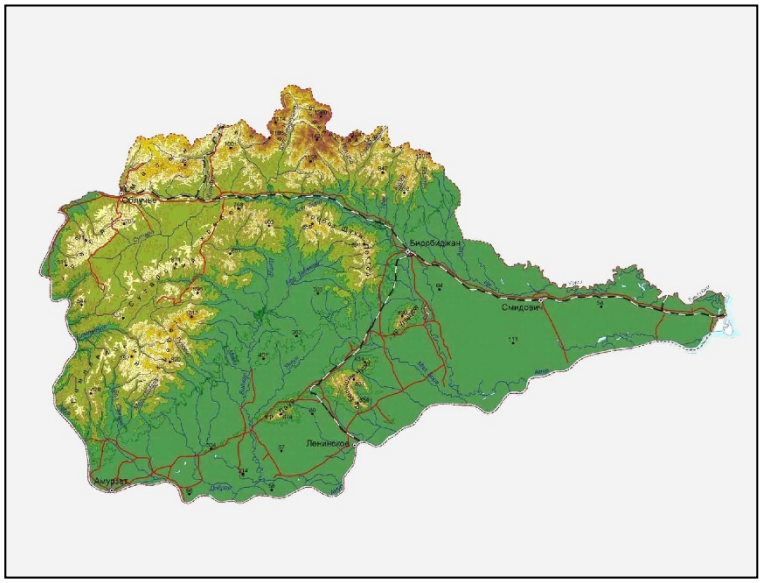


Fig. 1 b. Physical schematic map of the Jewish Autonomous Region

Despite its small size, the area differs with natural conditions. Mountainous north, swampy lowland east and plain south with small transitions between them, creating a heterogeneous territory and affecting the migration patterns of elements, help to understand the specific of each environment geochemistry of the areas included in its compound, and to identify features or nuances in the overall biogeochemical picture of autonomy (Fig. 1b).

Studying water sources of centralized and decentralized water supply and water distribution network of laboratories is carried out by laboratories of establishments of Rospotrebnadzor of EAO using atomic absorption, photometric and titrimetric methods. In this work we analyzed the results of determinations Fe, Mn, F and rigidity of drinking water in 2008-2012.

3. RESULTS AND DISCUSSION

Water supply of JAR settlements and industrial enterprises is mainly carried out by ground waters (99%). They lie at a depth of 10-15 m from the upper horizon in an upland areas and 3-5m – in the lower zones. In rural areas individual and shallow wells are used. About 50% of the area population use individual water supply [4].

Average concentrations of Fe and Mn, F and rigidity in drinking water of sources of centralized (deep wells) and decentralized (wells, columns, shallow wells) water and in water from the distribution network (water pipes) for 2008-2012 are presented in Tables 1-3. Fluoride is the only trace element, the main part of which comes in an organism with drinking water, from which it is absorbed by 90-97% [5]. According to sanitary norms Russian Federation (SanPiN 2.1.4.1074-01) for temperate regions, which include the JAR, optimal fluorine content in drinking water is considered to be 0.8 to 1.2 dm^3 [2].

Table 1

The fluorine content in drinking water (mg/dm^3) in JAR

JAR areas	Decentralized water supply sources (SanPiN 2.1.4.1175-02)		Centralized water supply sources (GOST 2761-84)		Distribution network (SanPiN 2.1.4.1074-01)	
	Average	The whole amount of samples	Average	The whole amount of samples	Average	The whole amount of samples
	MPC 1,5 mg/dm³					
Birobidzhan city	0,31	25	0,20	79	0,22	72
Birobidzhan district	0,41	22	0,28	49	0,16	10
Obluchensky district	0,32	18	0,31	83	0,22	71
Smidovichsky district	0,12	17	0,22	22	0,17	29
Leninsky district	-	-	0,36	20	0,23	16
Oktyabrsky district	-	-	0,19	19	0,18	14

Note: "-" - fluorine content of the sample were not studied

As can be seen from Table 1, there are no unsatisfactory samples (with excess of maximum concentration limit). Range of average concentrations of fluorine in drinking water is in the range of 0.12-0.41 mg/dm^3 (average 0.24 for all samples). The proportion of samples with trace concentrations of fluoride (less than 0.1 mg/dm^3) ranges from 15 to 25%. The average content of fluorine in drinking water of autonomy almost 2 times less than its optimum content.

According to the analysis of data, drinking water of decentralized water supply more enriched with fluorine than water from centralized sources, except Smidovichsky district. However in all municipalities element content of this element in water of decentralized sources is far from a necessary physiological minimum. In the distribution network fluorine content is reduced relative to centralized water supply sources, due to water purification, which is needed to reduce increased concentration of iron and manganese.

It is known that the drinking water having a reduced content of calcium and magnesium salts, have a low rigidity [2, 4, 13]. Since the study period analysis of samples for calcium and magnesium was not performed, we estimated drinking water on a rigidity index (Table 2). Physiological norm of rigidity ranges from 1.5 to 7 mg-eq/dm^3 [2].

Analysis of the table 2 data confirmed the previous information [4], that the drinking water of JAR is characterized by low rigidity. As can be seen, the average rigidity ranges from 0.7 to 3.2 mg-eq/dm^3, i.e. near the

lower limit of the physiological norm of drinking water or below the specified range. Unsatisfactory samples (with maximum concentration limit excess) are not present. The highest rigidity rates of drinking water is characterized by a decentralized water sources which is directly used by JAR population (with no purification), but it is close to the lower boundary of the physiological norm.

Table 2

Rigidity of drinking water (mg-eq/dm^3) in JAR territory (maximum concentration limit – 7 mg-eq/dm^3)

JAR areas	Decentralized water supply sources (SanPiN 2.1.4.1175-02)		Centralized water supply sources (GOST 2761-84)		Distribution network (SanPiN 2.1.4.1074-01)	
	Average	The whole amount of samples	Average	The whole amount of samples	Average	The whole amount of samples
	MPC - 7 mg-eqv/dm^3					
Birobidzhan city	2,1	134	1,3	67	1,1	125
Birobidzhan district	2,5	105	1,1	69	1,2	34
Obluchensky district	1,6	22	1,7	78	1,7	58
Smidovichsky district	2,6	21	1,5	131	1,6	316
Leninsky district	3,2	25	2,4	26	0,7	15
Oktyabrsky district	2,6	73	1,4	82	1,3	225

Thus, JAR residents drink "soft" drinking water.

Data on the content of iron and manganese in drinking water in JAR territory are presented in Table 3.

Table 3

Содержание марганца и железа в питьевой воде (мг/дм^3) на территории ЕАО

JAR areas	Decentralized water supply sources (SanPiN 2.1.4.1175-02)		Centralized water supply sources (GOST 2761-84)		Distribution network (SanPiN 2.1.4.1074-01)	
	Average	The whole amount of samples	Average	The whole amount of samples	Average	The whole amount of samples
	MPC Mn 0,1 mg/dm^3		*MPC Mn 1 mg/dm^3*		*MPC Mn 0,1 mg/dm^3*	
Birobidzhan city	0,95	25	0,17	104	0,10	80
Birobidzhan district	0,49	18	0,10	62	0,34	33
Obluchensky district	0,17	7	0,13	56	0,13	72
Smidovichsky district	0,16	4	0,65	40	0,16	44
Leninsky district	0,10	3	0,16	24	0,18	13
Oktyabrsky district	-	-	0,11	9	0,21	9
	MPC Fe 0,3 mg/dm^3		*MPC Fe 10,0 mg/dm^3*		*MPC Fe 0,3 mg/dm^3*	
Birobidzhan city	2,4	96	0,25	114	0,78	769
Birobidzhan district	0,92	45	3,49	157	0,80	957
Obluchensky district	0,11	19	0,3	349	0,17	1176
Smidovichsky district	1,78	35	6,7	223	1,73	1348
Leninsky district	0,29	161	4,99	49	1,13	699
Oktyabrsky district	0,41	81	3,23	61	1,20	504

Note: "-" - manganese content of the sample were not studied

Maximum concentration limit of Fe in drinking water from wells and columns (usually the private sector uses non-centralized water supply) and distribution network is 0.3 dm^3 - Water from these sources is used by the population directly, maximum concentration limit of Fe in water from deep wells (centralized water supply sources) is 10 dm^3, because this water passes purification system before it enters the distribution network. A similar situation is typical for the MPC of manganese.

Evidently, in the centralized water supply sources (wells, shallow wells) manganese concentration in Smidovichsky , Obluchensky districts especially Birobidzhan one as well as in Birobidzhan city exceed the MPC , in the Leninsky district are at the MPC level , in the October district sample content of this element have not been explored. Drinking water of Birobidzhan and Birobidzhan and Smidovichsky districts are characterized by the increased concentrations of iron. The lowest concentration of iron is in the waters of Obluchensky district, located in the mountainous part of the region, manganese - in the waters of the Leninsky district, occupying the south-eastern part of the region, which has the best conditions for the comprehensive development of agriculture. However, the number of water samples from centralized water supply sources, analyzed for Mn, is insufficient for convincing conclusions.

Centralized drinking water supply also provides about 50% of the population. Average concentrations of manganese and iron in the water of centralized sources (artesian wells and underflow derived for iron removal station) in all areas of the region do not exceed MPC. However, we can see raised content of manganese in the Smidovichsky districts in 10% of samples, specific weight of samples with excess of maximum concentration limit of iron here is the highest – 43%.

The content of toxic chemicals in drinking water after cleaning before entering the network is improved and mainly defined by operation of water supply facilities [7].

In centralized water distribution network in all areas of the region the average concentrations of manganese and iron in the water exceeds the MPC, except for Mn in drinking water of Birobidzhan. Consequently, the water supplied to consumers gets polluted by pipes, exceeding permissible level of elements, what makes useless water treatment at deferrization stations.

The research of F, Fe, Mn combined effects and rigidity on the formation of environmental-related diseases of JAR population conducted using factor analysis.

When studying of quantitative regularities and priority of a contribution of biogeochemical indicators and morbidity environmental-dependent classes of diseases (diseases of the musculoskeletal system and connective fabric, skin and subcutaneous tissue, blood circulation system) revealed that the two groups of factors explain 43.59% and 28.27% of the generalized dispersion.

To describe them, we calculated factor loadings. Considering the five-year observation period, significant at 95% confidence level is the value - 0.7 (semi-bold selection) [12]. Analysis of significant factor loadings allowed to interpret the group and identify priority of biogeochemical indicators.

The main hypothesis of the research is that one factor includes interrelated and interdependent variables, i.e. if morbidity and pollution parametrs get to same factor with the value of the factor loadings more than 0.7 [12], they are interdependent.

Results of the factor analysis of biogeochemical data and morbidity of the autonomy population are shown in Table 4. Semi-bold selection of factor loadings indicates of their importance and inclusion of these indicators in the review and analysis.

As can be seen, the first factor is described as indicators of the quality of drinking water rigidity and fluoride content in it, and data on morbidity diseases of the musculoskeletal system (adults, teenagers, and children) and diseases of blood circulation system (teenagers). The proportion of dispersion is 43.59%.

The second factor is the group, including the iron content in drinking water and morbidity of the skin and subcutaneous tissue diseases (children). The proportion of dispersion is 28.27%.

Thus, assessing the cumulative influence of biogeochemical indicators, we found that the leading role among them in JAR play rigidity of drinking water and the content of fluorine, affecting diseases of the musculoskeletal system and the blood circulation system. Second place in order of priority in JAR takes iron that influence diseases of the skin and subcutaneous tissue.

Table 4

Matrix of factor loadings

Name of variable	Factor loadings	
	A_1	A_2
Fluoride in drinking water	**-0,71**	0,10
Rigidity of drinking water	**-0,82**	0,40
Iron in drinking water	-0,07	**0,76**
Manganese in drinking water	-0,20	0,09
Diseases of the musculoskeletal system (adults)	**-0,86**	0,04
Diseases of blood circulation system (adults)	-0,67	-0,52
Diseases of the skin and subcutaneous tissue (adults)	0,48	0,28
Diseases of the musculoskeletal system (teenagers)	**0,70**	-0,18
Diseases of the musculoskeletal system (teenagers)	**0,85**	-0,42
Diseases of the skin and subcutaneous tissue (teenagers)	0,64	0,30
Diseases of the musculoskeletal system (children)	**0,84**	-0,29
Diseases of the musculoskeletal system (children)	0,61	0,07
Diseases of the skin and subcutaneous tissue (children)	0,49	**-0,88**
% of total dispersion	43,59	28,27

4. CONCLUSION

This research showed that drinking waters of Jewish Autonomous Region have poor content of fluorine, excess – iron and manganese and a low rigidity. Use of factor analysis revealed that the leading biogeochemical indexes influencing incidence of the population of diseases of musculoskeletal system and system of blood circulation, are the rigidity index of water and the content of fluorine in it. The content of iron in drinking water is the second priority indicator influencing child morbidity of skin and subcutaneous tissue diseases.

REFERENCES

Avtsyn A.P., Zhavoronkov A.A., Rish M.A., Strochkova L.S. Human microelementoses. M.: Medical, 1991. 496 p.

Skalny A.V., Rudakov I.A. Bioelements in medicine. M: Publishing House "Onyx 21", 2004. 272 p.

Sharov P.O. Lead contamination township Rudnaya Pristan and its impact on children's health. Vladivostok: Dal'nauka, 2005. 132 p.

Khristoforova N.K., Klinskaya E.O., Surits O.V., Bondarev D.G., Antonova M.S. Jewish Autonomous Region as biogeochemical province. Birobidzhan: Publishing House of the FGBOU VPO "PSU named. Sholem Aleichem", 2012. 250 p.

Gabovich R.D., Minh A.A. The hygienic problems fluoridation of drinking water. M: Medical, 1979. 200 p.

WHO, Fluoride // Trace elements in human nutrition and helth. Geneva: World Helth Organization, 1996. P. 187-195.

Avtsyn A.P., Zhavoronkov A.A. Pathology fluorosis. Novosibirsk: Nauka, Siberian Branch, 1981. 330 p.

Messer H. H. Fluorine // Biochemistry of the essential ultra-trace elements / Ed. E. Frieden. New York: Plenum Press, 1984. P. 55-87.

Szot L., Geisler J. Influence of fluoride ion on the calcification process in rat bone // Acta Biochem. Polon, 1967. V. 14. № 1. P. 11-120.

Deshmukh D. S., Merander J. C., Shah B.G. The effect of dietary fluoride on calcium and phosphorus metaboloism of rats. Canad. J. Physiol. A. Pharmac, 1970. V. 48. P. 503-509.

Revich B.A., Avaliani S.L., Tikhonov G.I. Environmental epidemiology. M.: Publishing Center "Academy", 2004. 384 p.

Brooks K., Carruthers N. Application of statistical methods in meteorology. L.: Gidrometeoizdat, 1963. 309 p.

Novikov J.V., Plitman S.I., Levin A.I. Hygiene standards of the minimum content of magnesium in drinking water // Hygiene and Sanitation. 1983. Issue. 9. P. 7-11.