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## **Environmental risks for children oral health in Low Danube region**

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### **Abstract**

The study was aimed to assess the environmental risks for children oral health in Low Danube region.

**Material and methods.** The study was conducted in 2011-2021. Information on the state of drinking water, the level of environmental safety of food, qualitative and quantitative composition of food was obtained from the reports of territorial institutions of the sanitary-epidemiological service of Odessa region. Actual nutrition was assessed using standard questionnaires. The assessment of the level of environmental and hygienic safety was based on the recommendations of the EPA. Statistical processing was performed by methods of analysis of variance and correlation using specialized software Statistica 10.0.

**Results.** Excessive carbohydrate intake and excessive nitrate load are the main environmental risk factors for dental pathology in children living in the Danube region. Qualitative composition of diets plays a bigger role than mineral composition of drinking water.

**Conclusion.** 1. Drinking water of suboptimal mineral composition was consumed by 41.7% of people, high content of refined carbohydrates was inherent in the diets of 63.0% of surveyed children.

2. Children's diet is characterized with subdeficiency of B vitamins, excessive consumption of refined carbohydrates and a significant nitrate load.

**Key words: oral health; children; nutrition; drinking water; environmental risk**

Dental diseases are most common in the population [1-3]. More than 530 million children worldwide suffer from caries of deciduous teeth [3]. In the future, these children often have lesions of the teeth of permanent occlusion [1, 3, 4].

In recent years, much attention is paid to the regional features of the epidemiology of dental diseases in childhood, including due to the traditional way of life of different ethnic groups, the state of ecological and hygienic safety, general socio-economic development of regions [5, 6].

The Low Danube is a unique natural, economic and ethnic area of Odessa region, located in the southwestern part of the Black Sea lowlands [7, 8]. Extensive transport links, developed agro-industrial complex, the presence of large industrial enterprises certainly affect the conditions of formation of both general and dental health [8]. The peculiarities of the region are the multiethnic composition of the population [7]. At the same time, some problems persist in the Low Danube region for a long time, including the shortage of good quality drinking water, unsatisfactory development of the primary health care system, e.g the network of dental care facilities for children [9].

The study was aimed to assess the environmental risks for children oral health in Low Danube region

#### Material and methods

The study was conducted in 2011-2021. Information on the state of drinking water, the level of environmental safety of food, qualitative and quantitative composition of food was obtained from the reports of territorial institutions of the sanitary-epidemiological service of Odessa region. Actual nutrition was assessed using standard questionnaires [10]. The assessment of the level of environmental and hygienic safety was based on the recommendations of the EPA [11].

Statistical processing was performed by methods of analysis of variance and correlation using specialized software Statistica 10.0 [12].

#### Results

Water supply of Izmail is carried out from underground sources. Water from wells enters the reservoirs, is chlorinated and fed into the distribution network, the length of which

within the city is 336 km. ZSO of a strict mode are fenced, kept in a satisfactory condition. The results of social and hygienic monitoring showed that the underground water supply sources of Izmail are mainly class 1 sources, which indicates compliance of drinking water with regulatory requirements.

The city's water consumption is 25 thousand m<sup>3</sup> / day with a design capacity of 43.1 thousand m<sup>3</sup> / day. The source of water supply is 43 artesian wells. There are 32 artesian wells: "Fortress" - 12 wells, p. Matroska - 14, str. Nakhimova - 5, street Chekhov - 1. Water intake from the Danube has been disconnected since 1997. Depth of artesian wells 50 - 70 m. Water from wells is extracted using submersible pumps. Chlorination is carried out by electrolysis plants at VNS "Danube" and VNS "Fortress".

The city water supply works around the clock. Territories of ZSO of water intakes of the city water supply system are fenced, are kept satisfactorily.

The unresolved issue is the replacement of water supply networks. A significant part of water supply networks was put into operation in 1950-1970, has fulfilled its standard service life: 65% are worn out, 35% are in disrepair.

During 2018, 482 samples of sanitary and microbiological indicators were examined for sanitary and microbiological indicators (all of them meet the requirements); according to sanitary and chemical indicators - 415 water samples, of which 6 samples do not meet the requirements according to organoleptic indicators. Also, 669 samples of drinking water were examined according to sanitary-microbiological indicators (non-standard 0) and 526 according to sanitary-chemical indicators (non-standard 4 in terms of turbidity and iron content).

There are no public and individual mine wells in the city.

There are no individual and public catchments in Izmail district; public mine wells - 5. In 2018, 792 samples of drinking water were tested according to sanitary-microbiological indicators (non-standard 27, including 35 samples from wells, of which do not meet the requirements -12 samples) and 680 according to sanitary-chemical indicators (31 non-standard water samples, including 37 from wells, 12 of which do not meet the requirements for hardness and chlorides).

Under supervision are 3 creatures of observation of reservoirs of the I category (Danube river). The objects of sewerage are the combined treatment facilities, which are located on the territory of OJSC "Izmail Pulp and Cardboard Plant". Sewage treatment plants receive domestic and domestic sewage from the city and sewage from the plant.

In general, in the Izmail district, 8 observation sites of reservoirs of the I and II

categories are under surveillance: I - lake. Katlabukh, Suvorove village (three creatures); Katlabuh Lake, Bagate village; Danube, Kislytsia village; II - lake. Safyani, s. Safyani; lake China, s. Sorrel - one shot each.

In Izmail district, the number of sources of centralized water supply -21; departmental water supply systems (including from open reservoirs) - 6 (1 - Safyany village, 1 - Dunayske village, 4 - S. Nekrasivka village); rural water supply systems (including from open reservoirs) - 4 (villages of Broska, Matroska, Loshchinovka, Bagate).

Sources of decentralized water supply: wells, catchments, artesian wells - 8 (5 public mine wells in the villages of Kalanchak, Kamyshivka, Kirnychky, Novoozerne, Pershotravneve; 1 water supply point of Grant-Service LLC; 1 - VOC -50 v. Kislytsia).

There are no water mains in unsatisfactory sanitary condition in the district. Percentage of worn-out water supply networks that need to be replaced - 40% of Chapaeva Insurance Company, p. Safyani; 35% - s. Rich; number of accidents on networks - 3 (village of Bagate). Water supply is available around the clock.

In the village. Bagate and s. Safyans they use disinfectants for water supply.

Departmental laboratory control is carried out by the Izmail city and district branch of the State Institution "Odessa OSU DSES";

In the Izmail area certain work on implementation of measures of improvement of a condition of economic and drinking maintenance is carried out. So in the village of Suvorov, ss. Kyrnychky, N. Pokrivka, Pershotravneve, Utkonosivka, Kamyanka (settlements that do not have their own sources of quality water supply), the population was notified by village (settlement) councils about carriers (suppliers) of drinking water and sources of quality water supply (well LLC "Grant- service ", Safyany village).

Cleaning and disinfection of the distribution network in the village of Safyany (on the balance of Chapaeva Insurance Company), pools for storage of drinking water supplies in Vyshenka Primary School, secondary school and FAP in the village of N. Cover; public mine well with. Kamyshivka; mine well of the therapeutic department №1 of the Central Regional Hospital of the Izmail district (the village of Kamyanka). The measures taken to some extent stabilize the growth of infectious diseases of the population of the district associated with the use of drinking water. However, it is impossible to radically improve the water supply of the population of Izmail district, as the district program "Drinking water of Odessa region in Izmail district by 2008-2020p.p. » has not been funded since 2008.

The level of air pollution in Izmail is due to the presence of dust, sulfur dioxide and nitrogen, carbon monoxide, soluble sulfates, hydrogen sulfide and formaldehyde. The state of

air pollution is also affected by the total effect of nitrogen and sulfur oxides and the content of benzene / a / pyrene.

The main sources of air pollution are emissions from industrial and domestic boilers, transport. The city has a pulp and paper mill, a port, the Ukrainian Danube Shipping Company, shipyards, local industries, road, river, sea and rail transport. However, in a more detailed assessment of the risks of the impact of environmental factors on children's health, the intensity of this impact was low, so during 2016-2019, only 3% of drinking water was non-standard.

As can be seen from Table 1, many of the indicators are on the border of the MPC. This is due to the presence of sources of pollution in the region and the unsatisfactory sanitary condition of some water sources, especially municipal water mains and wells.

As for the drinking water of the Reni district, they generally met (Table 2) the current hygienic standards, but in some water sources the water had a high total mineralization and hardness. Particularly unfavorable in terms of salt composition were drinking water from wells in the village. A basin where the total hardness of drinking water exceeded 20 mg eq per dm<sup>3</sup>.

A similar situation has developed in the Kiliya district. As can be seen from Table 3 below, most water sources have drinking water of satisfactory quality. The only exception is a well in the village of Stary Troyany, where the water contains nitrates at the MPC boundary.

Much of the Kiliya district uses the Kiliya group water supply system. This system, designed in the late 1980s, was expanded in 2007-2010. It can provide 25,000 cubic meters of clean drinking water per day. Water is taken from the Danube, "lifting" through the main pumping and treatment plant on large water mains and through other pumping stations. transmitted to the consumer. The same system is used for water supply of part of the territory of Tatabunary district.

There is a shortage of drinking water in the area of the village of Primorskoe, which has become a popular resort in recent years. According to social and hygienic monitoring, the amount of water per person does not exceed 50 liters per day.

At the same time, there is a decrease in the content of nitrates in groundwater, compared with data from 10-20 years ago [13]. We do not consider drinking water as the only source of nitrites and nitrates, in modern conditions food sources can play a much bigger role.

Table 1 - The results of a study of drinking water quality in the Izmail region

The source of water	General hardness, mg eq/l	Chlorides, mg/l	pH	Residual chlorine, mg/l.	Ammonia, mg/l	Nitrites, mg/l	Nitrates, mg/l
WSS "Fortress"	3,1±0,1	79,3±1,6	7,5±0,1	0,33±0,04	<0,05	<0,003	27,1±1,9
FW №2	4,0±0,2	44,8±3,4	7,6±0,1	НД	<0,05	<0,003	3,9±0,3
FW №3	2,6±0,1	66,0±1,2	7,5±0,1	НД	<0,05	<0,003	8,1±0,7
FW №4	2,5±0,1	40,0±1,1	7,5±0,1	НД	<0,05	<0,003	23,4±1,1
FW №5	3,8±0,1	90,6±2,7	7,4±0,1	НД	<0,05	<0,003	11,3±0,9
FW №6	<b>6,6±0,5</b>	109±1,6	7,5±0,1	НД	<0,05	<0,003	3,1±0,4
FW №7	4,2±0,2	104,0±2,7	7,5±0,1	НД	<0,05	<0,003	31,6±2,3
FW №9	3,1±0,1	57,0±1,5	6,9±0,1	НД	<0,05	<0,003	17,6±1,4
FW CB. №10	3,5±0,1	110,0±2,8	7,6±0,1	НД	<0,05	0,003	14±0,8
FW №11	3,8±0,1	84,1±2,4	7,4±0,1	НД	<0,05	<0,003	18±0,9
FW №12	7±0,1	79,2±2,1	7,5±0,1	НД	<0,05	<0,003	3,6±0,2
WSS "Matroska"	<b>3,3±0,1</b>	34,6±2,3	7,5±0,2	0,28±0,06	<0,05	<0,003	3,6±0,1
MW №1	4,9±0,1	119±1,9	7,6±0,2	ND	<0,05	<0,003	18,4±0,9
MW №5	4,6±0,1	135,0±3,6	7,3±0,2	ND	<0,05	<0,004	47,6±1,4
MW №7	<b>4,9±0,1</b>	96,4	7,5±0,2	ND	<0,05	<0,003	38,4±0,7
MW №17	4,6±0,1	37,1	7,5±0,2	ND	<0,1	<0,003	3,6±0,1
MW №18	2,0±0,1	29,07	4,0±0,1	ND	<0,05	<0,003	1,2±0,1
MW №20	5,0±0,1	30	7,8±0,2	ND	<0,05	<0,003	2,1±0,1
WSS "Danube"	3,8±0,1	107,0	7,6±0,2	0,56±0,1	<0,05	<0,003	18,6±0,2
DW №8	3,5±0,1	33,2	7,4±0,2	ND	<0,05	<0,003	14,8±0,3
Danube №9	3,5±0,1	70,0	7,5±0,3	ND	<0,05	<0,003	9,6±0,2
Danube №10	4,1±0,1	90,0	7,6±0,3	ND	<0,05	<0,003	11,2±0,4
Safiani, rural WSL	3,7±0,1	112	7,4±0,2	ND	<0,05	<0,003	8,9±0,3
MWSL "Spring"	5,6±0,1	208	7,4±0,3	ND	<0,05	0,003	9,6±0,3
Safiani, public mine well	5,5±0,1	300	7,2±0,2	ND	<0,05	0,003	3,6±0,1
Deep well "Grant-Ser"	3,1±0,1	80	7,6±0,3	ND	<0,05	0,003	6,3±0,1

Table 2 The results of a study of drinking water quality in the Reni district

The source of water	General hardness, mg eq/l	Dry residuum, mg/l.	Chlorides, mg/l	Sulphates, mg/l	Calcium, mg/l	Magnesium, mg/l	Iron, mg/l	pH	Ammonia, mg/l.	Nitrates, mg/l	Nitrates, mg/l
<i>Reni</i>	6,2±0,2	818,4±22,3	110,0±11,1	240,0±15,4	72,1±3,5	31,6±3,3	0,5±0,1	7,2±0,4	<0,05	<0,003	<0,01
<i>Dolinske</i>	7,9±0,2	835,0±19,4	90,2±9,9	345,6±24,3	72,1±3,3	52,3±4,5	0,3±0,1	7,1±0,4	<0,05	<0,003	<0,01
<i>Kotlovina</i>	7,7±0,2	805,5±18,8	120,0±12,2	302,4±26,3	60,1±4,2	57,2±4,8	1,0±0,1	7,1±0,3	<0,05	<0,003	<0,01
<i>Limanske</i>	7,0±0,1	793,2±21,2	90,5±11,3	248,0±25,2	72,1±2,8	34,0±3,8	-	7,2±0,3	<0,05	<0,003	<0,01
<i>Nagirne</i>	6,6±0,1	676,6±13,3	70,2±8,8	264,4±24,4	70,2±3,1	37,7±4,2	0,9±0,1	7,2±0,2	<0,05	<0,003	<0,01
<i>Novosilske</i>	6,2±0,1	789,0±23,5	50,8±4,3	248,0±22,8	72,4±2,8	47,0±4,0	-	7,2±0,4	<0,05	<0,003	<0,01
<i>Orlovka</i>	7,0±0,2	878,0±18,6	180,6±14,2	250,0±23,5	60,1±3,2	72,8±5,6	1,17±0,2	7,3±0,3	<0,05	<0,003	<0,01
<b>Well at Soborna St.,45a</b>	26,0±1,3	<b>2137,3±33,3</b>	<b>748,8±21,2</b>	<b>547,0±32,5</b>	<b>266,4±11,2</b>	<b>184,8±9,8</b>	-	<b>7,4±0,4</b>	<b>&lt;0,05</b>	<b>&lt;0,003</b>	<b>105,3±14,4</b>
<b>Well at 28<sup>th</sup> June St., 61</b>	<b>29,1±2,2</b>	<b>1864,4±23,4</b>	<b>511,4±16,3</b>	<b>574,0±28,6</b>	<b>280,3±9,9</b>	<b>183,0±10,4</b>	-	<b>7,2±0,3</b>	<b>&lt;0,05</b>	<b>&lt;0,003</b>	<b>110,9±12,2</b>

Table 3 The results of a study of drinking water quality in the Kiliya district

The source of water	General hardness, мг- екв/дм куб.	Dry residuum, mg/l	Chlorides, mg/l	Iron, mg/l	pH	Residual chlorine, mg/l.	Ammonia, mg/l	Nitrites, mg/l	Nitrates, mg/l.
<i>Kylia</i>	3,8±0,2	265,0±22,2	31,0±1,5	<0,05	7,6±0,4	0,35±0,03	0,07±0,01	0,007±0,001	3,5±
<i>Municipal WSL</i>	3,7±0,3	262,2±23,3	33,2±1,4	0,12±0,02	7,7±0,3	0,17±0,02	0,06±0,01	0,005±0,001	3±
<i>Shevschenko</i>	3,1±0,2	250,5±24,4	34,5±1,2	0,13±0,02	7,7±0,3	0,28±0,03	0,08±0,01	0,006±0,001	2,9±
<i>Novoselivka</i>	3,3±0,2	256,0±24,2	35,9±1,4	0,11±0,02	7,8±0,4	0,35±0,04	0,09±0,01	0,007±0,001	3,1±
<i>Primorske</i>	3,7±0,3	324,4±26,5	77,3±3,3	0,14±0,02	8,0±0,5	0,56±0,08	0,18±0,02	0,032±0,001	4±
<i>Stari Troyani</i>	9,9±0,9	333,3±25,8	189,9±11,7	0,14±0,02	7,8±0,4	-	0,15±0,02	0,042±0,001	40,2±



The content of nitrates in food products varies depending on the season and the applied agronomic solutions. According to Babienko VV (2011) for some vegetables (beets, carrots, potatoes, salad vegetables) in such areas of Odessa region as Mykolayiv, Bilyaevsky, Belgorod - Dniester, Izmail, Bolgrad, Saratov, Artsyz, Tatarbunary there was a 2-5-fold exceedance of the MPC content of nitrates [ 14]. The author considers the main source (up to 80%) of nitrates in the human body vegetable products. Based on this hypothesis, we estimated the daily intake of nitrates in the diet of children living in the Danube region.

This figure was 1.4-1.7 mg / kg body weight per day, which can be considered a safe level. At the same time, children's diets were characterized by excessive consumption of unprotected carbohydrates and fats. This led to the high energy value of the diet, which averaged 25-30% higher than recommended. Despite the fact that in the Danube region, well-developed agriculture for daily rations was also characterized by an imbalance in the consumption of vitamins (Table 4).

Table 4 - Characteristics of diets of children

Nutrients		7 y.o.	12 y.o.	15 y.o.
Protein, g	Animal	44,3±2,4	62,7±3,2	68,9±3,4
	Vegetable	29,5±1,3	30,6±1,8	28,7±2,8
Fat, g	Animal	40,3±2,4	58,8±2,8	60,7±3,4
	Vegetable	18,1±0,9	24,8±1,6	28,4±2,6
Carbohydrates, g	Refined	99±9	123±16	138±17
	Protected	222±12	256±21	262±19
Vitamins, mcg	B1	1,2±0,1	1,5±0,1	1,7±0,1
	B2	1,2±0,1	1,4±0,1	1,6±0,1
	B6	1,1±0,1	1,5±0,1	1,4±0,1
	PP	15±1,2	16±1,4	18±1,3
	C	61±5	73±4	76±7
Nitrates, mg		44±1,8	66±1,6	74±1,9

According to our data, drinking water of suboptimal mineral composition was consumed by 41.7% of people, high content of refined carbohydrates was characteristic of the diets of 63.0% of surveyed children.

In general, the complex of studies indicates the presence of a subdeficiency of B vitamins, excessive consumption of refined carbohydrates and a significant nitrate load.

#### Discussion.

The subregion of the Ukrainian Danube is located in the south-western part of the Odessa region, which is located in the Danube-Dniester interfluvium of the Danube; includes 5 administrative districts - Bolgrad, Izmail, Kiliya, Reni and the city of regional subordination Izmail [7, 8, 13, 14]. The total area of the region is 6.6 thousand km<sup>2</sup>. The Lower Danube

Euroregion includes Odesa Oblast (Ukraine), Cahul County (Moldova) and Braila, Galati and Tulcea (Romania) counties.

The Danube territories included in the Euroregion [8, 15] have a certain set of common problems:

- insufficient, and according to some indicators - a low level of socio-economic;
- significant heterogeneity of the ethnic composition of the population of border areas, high proportions of national minorities with signs of ethno-social tension;
- low level of employment, high unemployment (often in a hidden form);
- political and socio-economic tensions;
- imperfect structure of the economy of the border regions: low level of development of the service sector and the social sphere in general, insufficient level of industrial development, weak infrastructural and communication facilities of the territory. Low-tech and unbalanced (in terms of storage and processing of agricultural products) development of the agro-industrial sector of the economy, which is leading for these areas [7-9, 15];
- significant, especially for Moldova and Ukraine, transport isolation of the Danube regions from the main centers and districts. Poorly developed transport and communication infrastructure [9];
- low level of international and interregional cooperation of the Lower Danube regions. Late and extremely insufficient entry of the countries participating in the project into European and world markets;
- tense socio-ecological situation due to low quality of drinking water and lack of regional active and coordinated at the international and interregional levels of environmental and socio-environmental policy.

The region has a high level of disease, fish often die in the Danube lakes and reservoirs, for a long time there is a threatening epidemiological situation [9, 15]. The difficult ecological situation is one of the main problems hindering the economic development of the Ukrainian Danube [9].

Among the recommendations in the National Strategy for the Implementation of the EU Strategy for the Danube Region was stated: "In order to improve the quality of centralized water supply and drainage in the Ukrainian Danube, consider the use of new sources of water supply (Danube groundwater)" [15]. This idea is still unrealized, the quality of drinking water remains low, and the amount of drinking water consumed is one of the lowest in the region [13].

The Strategic Plan for Improving the Competitiveness and Economic Development of the Danube Economic Subregion for 2012-2022 [15] stated that the development and implementation of projects to provide quality drinking water to the population will have a

positive impact on both public health and tourism in the region. However, as of early 2020, these programs have not been implemented.

The use of resources of the Danube lakes - Cahul, Kugurlui, Yalpug, Katlabug, China, which suffer from growing anthropogenic pressure, remains threatening [16]. This leads to an increase in the content of inorganic nitrogen in the water of lakes, intensification of eutrophication processes, degradation of existing ecosystems.

Conditions of water supply in different settlements of the Danube differ. Reni and Izmail districts use mainly groundwater and interstratal groundwater, the water quality in the Danube River does not allow its use as a source of drinking water [13]. Kiliya and Bolgradsky districts mostly use surface waters and wells, many of which are in unsatisfactory sanitary condition or have highly mineralized hard waters. In Kiliya and Vilково, Danube water is still used. The city of Bolgrad uses Lake Yalpug as a source of drinking water supply. In general, the ecosystem of the Ukrainian Danube region is subjected to intense anthropogenic and man-made stress, which is accompanied by negative changes in the quality of surface water and drinking water. Unfortunately, the directions of measures to improve the situation declared during the last decade have not been practically implemented.

In the study Kovalchuk LY (2015) showed that metabolic and structural changes in the body of healthy rats that consumed drinking water from Lakes Cahul, Yalpug, Katlabukh, are confirmed by the results of assessment of genotoxicity and mutagenicity of these water samples [16]. In particular, this applies to the compensation of the insufficiency of the energy system by the LPS system, which creates the preconditions for the formation of changes in the immune response of rats (especially for the water of Lakes Cahul and Yalpug) and less for the water of lakes Катлабух; and structural changes in the body of rats, which were concentrated in the liver, brain, spleen. Toxicity and m

#### Conclusion

1. Drinking water of suboptimal mineral composition was consumed by 41.7% of people, high content of refined carbohydrates was inherent in the diets of 63.0% of surveyed children.
2. Children's diet is characterized with subdeficiency of B vitamins, excessive consumption of refined carbohydrates and a significant nitrate load.

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