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INFLUENCE OF DRINKING WATER QUALITY ON THE POPULATION HEALTH IN THE HULYAIPILSKYI RURAL DISTRICT

Hryhorenko L. V.

Introduction. The data presented by us is characterize priority problems in the field of drinking water supply and quality of drinking water that are relevant for many regions of Ukraine, including for Hulyaipilskyi district of the Zaporizhzhskyi region, whose population receives drinking water with deviations in some indicators from hygienic standards.

Objective - to study impact of mineral composition of drinking water on the health state population in five experimental districts (Vozdvyzhenskyi, Komsomolskyi, Novozlativskyi, Uspenivskyi and Malynovskyi) of Zaporizhzhskyi region in comparison with control Hulyaipilskyi district (with the lowest levels of diseases among population).

Materials and methods. Study of drinking water quality from centralized and decentralized water supply sources in Hulyaipilskyi district (102 studies in total). Indicators of general and primary morbidity among adult population in Hulyaipilskyi district were studied for the last 5-year period (280 studies in total). Indicators of general and primary morbidity among adult population in the individual hospital districts were analyzed according to the medical records (350 studies totally).

Results. Deterioration of the qualitative composition of drinking water with an increased level of total mineralization during 2015–2019 was established on the territory of individual rural areas: from 1.15 to 21.82 times. A reliably high level prevalence of kidney stones and diseases of the urinary system, diseases of the circulatory system, hypertension, coronary heart disease was shown in the territory of rural districts: Komsomolskyi, Novozlatopilskyi, Uspenskyi and Malinovskyi among adult population, compared with average annual indicator in the Hulyaipilskyi rural district ($p < 0.001$).

Conclusions. There was a tendency to increase incidence of hypertension in all rural hospital areas during 2015–2019 years. Statistically significant correlation of average strength were revealed between individual components of the mineral composition of drinking water: hardness, dry residue, total mineralization and prevalence of III, XIV classes of diseases by ICD-10 *($r = 0.30$, $p < 0.05$).*

KEY WORDS: rural districts, drinking water, average annual indicator, mineral composition, III, XIV classes of diseases

INFORMATION ABOUT AUTHOR

Hryhorenko Luibov, Doctor of Medical Sciences, associate professor of the department of Hygiene, Ecology and Occupational Safety, SI «Dnepropetrovsk Medical Academy Ministry of Health of Ukraine», 2, Soborna Sq., Dnipro, Ukraine, 49027, email: hryhorenkoluibov@ukr.net, ORCID ID: https://orcid.org/ 0000-0002-9517-5975

INTRODUCTION

Drinking water is one of the most important components of natural environment, which has a significant impact on public health. It plays a significant role in human life, in ensuring the sanitary and epidemiological well-being of population, but at the same time poor quality of drinking water can be a factor influencing to the development of somatic and infectious diseases [1–3].

Monitoring of drinking water quality from centralized water supply systems, which is carried out in Ukraine shows that in some regions of the country drinking water does not always meet regulatory requirements [4].

The largest number of underground water intakes with unconditioned drinking water is operated in Dnipropetrovsk region. The mineral composition of groundwater has deviations from hygienic standards for the largest number of indicators (from 3–4 to 7–8) [5]. Outbreaks of non-conditioned drinking water from groundwater intakes are registered in Dnipropetrovsk, Kirovohrad, Kherson, Odesa, Lviv, Ivano-Frankivsk regions [6].

Trends relevant to public health are characterized by reports of a decrease in reported outbreaks of water etiology, according to official annual statistical reports of state water supply control systems, on the background of actual annual increasing the proportion of water outbreaks in individual water supply systems and extensive rate of outbreaks, associated with shortcomings of sanitary nature in the state water supply systems. There are no official data on the proportion of water outbreaks associated with distribution network of centralized water supply systems and elimination of deficiencies, caused by use of untreated drinking water or insufficient groundwater treatment in the decentralized water supply systems [7–12].

Results of our previous research works confirmed hypothesis of the impact salt and mineral composition of drinking water on the infectious and non-infectious morbidity among population of Dnipro region. It is determined that population of the northern part of Dnipro region consumes chlorinated tap drinking water with a slightly higher content of organic matter (ammonia nitrogen, nitrites, nitrates, oxidation and pH), as evidenced by the results of our previous studies [13]. It is known that nitrates and high levels of organochlorine compounds are carcinogens [14]. Thus, in the north of Dnipro region, even in ecologically favorable rural conditions, there is a higher incidence of congenital anomalies (57.57 ± 3.37), circulatory system anomalies (10.83 ± 0.81), neoplasms (19.48 ± 1.73), which is explained by carcinogenic, mutagenic and embryotoxic effect of organochlorine compounds in tap drinking water from centralized water supply systems [15–17].

In our opinion, tendency to increase level of non-communicable diseases – blood and hematopoietic organs, anemia, circulatory system, digestive system, urogenital system among population is associated with increased content of macro-and micronutrients (Ca, Mg, Fe, F, Zn) and salt composition (total hardness, dry residue, chloride and sulfate content) in drinking water from wells in the south of Dnipro region. In particular, increased iron content in water from centralized systems of individual wells in the rural areas: absolute values (minimum–maximum content) was varied from 0.45–0.80 mg/dm^3 (2.25–4 MPC) to 0.85–0.90 mg/dm^3 (4.2–4.5 MPC) caused a high relative risk of circulatory system diseases *(RR = 2.50, $p < 0.05$)* [18].

The relevance of study is unquestionable, as over the last 40 years, almost no authors, who cared about impact of drinking water on the health of rural residents.

OBJECTIVE

Objective – to study impact of mineral composition of drinking water on the health state population in five experimental districts (Vozdvyzhenskyi, Komsomolskyi, Novozlativskyi, Uspenivskyi and Malynovskyi) of Zaporizhzhskyi region in comparison with control Hulyaipilskyi district (with the lowest levels of diseases among population)

MATERIALS AND METHODS OF RESEARCH

According to the salt composition of drinking water experimental group was identified. It includes adult population in the five experimental districts (Vozdvyzhenskyi, Komsomolskyi, Novozlativskyi, Uspenivskyi and Malynovskyi) and control group: rural population of Hulyaipilskyi district.

The basic criteria of study experimental and control district was types of water supply (in the experimental districts – majority of water sources were decentralized – public and private wells, which were not control by sanitary inspection). In the control (Hulyaipilskyi district) was used water from centralized systems, which was control by sanitary service of the region. In the control district was observed the lowest levels of diseases among population, according to the data of official statistical reports for the las five years.

Study of drinking water quality from centralized and decentralized water supply sources in Hulyaipilskyi district of Zaporizhzhskyi region was studied according to the sanitary-chemical analysis: average values of average daily concentrations of total hardness, dry residue, chlorides, sulfates (102 studies in total). Indicators of general and primary morbidity among adult population in Hulyaipilskyi district were studied according to the statistical reporting from regional information center of health care department for the last 5-year period (280 studies in total). Indicators of general and primary morbidity among adult population in the individual hospital districts were analyzed according to the medical records: case histories and dispensary

cards in outpatient clinics of Hulyaipilskyi rural district (350 studies totally).

Analysis indicators of diseases was carried out by method of retrospective continuous observation (statistical form № 20). Statistical grouping of materials about prevalence of diseases and morbidity of population carried out in accordance with «International Statistical Classification of Diseases» (ICD-10). The *Excel* package was used for the initial preparation of tables and intermediate calculations. The main part of mathematical processing performed on PC using the standard statistical package *STATISTICA 10.0 portable*. Cluster analysis allowed us to divide territory of region in a multidimensional space into hospital districts: Hulyaipilskyi, Vozdvyzhenskyi, Komsomolskyi, Novozlatopilskyi, Uspenivskyi, Malinovskyi, which differ both in the character of water supply (mainly centralized and with imported drinking water) and in the salt composition of drinking water. Mathematical processing included the following methods: calculation of primary statistical indicators, identification of differences between groups on statistical grounds; establishment of dependence by means of one-factor and multifactor linear regression analysis, methods of multidimensional statistics (cluster analysis), relative risks.

RESULTS AND DISCUSSION

The characteristic feature of water supply systems in the settlements of the given area is that drinking water is not subject to additional treatment, although such indicators as hardness, dry residue, mineralization of water does not meet the requirements of DSanPiN 2.2.4-171-10 «Hygienic requirements for drinking water intended for human consumption».

Majority of the rural population uses imported drinking water. It was established that the worst quality of drinking water is observed in Komsomolskyi and Uspenovskyi hospital units. The level of total mineralization on the territory of experimental district fluctuated in the limits (1731.9–1970.87) mg/dm³ in Komsomolskyi and (1350.8–2182.2) mg/dm³ in Uspenovskyi hospital units (by absolute values).

The average statistical values for indicators of drinking water quality in the experimental and control districts represented in the (tab. 1).

Table 1

Statistical difference in drinking water quality in the different water supply systems in the experimental and control areas (M ± m)

Indicator	M_1 average arithmetic mean (in control – Hulaipilskyi district)	m_1 error of average, arithmetic mean	M_2 average arithmetic mean (in five experimental-districts)	m_2 average arithmetic mean	Student's coef-ficient (t)	Proba-bility (p)	Fisher coefficient (F)	Proba-bility (p)
Rigidity	7,32	0,38	8,31	0,50	-1,56	0,120	1,748	0,026
Sulfates	1188,31	130,58	868,71	81,69	2,07	0,040	2,555	< 0,001
Ca	76,66	4,09	64,05	4,32	2,11	0,036	1,115	0,661
Mg	35,37	2,04	36,40	3,04	-0,28	0,780	2,230	0,001
Fe	0,17	0,04	0,15	0,01	0,31	0,752	8,362	< 0,001
Zn	0,09	0,003	0,08	0,004	1,98	0,049	1,618	0,054
Cu	0,09	0,005	0,09	0,007	0,14	0,888	1,725	0,029
F	0,13	0,006	0,24	0,02	-4,85	< 0,001	14,902	< 0,001
pH	7,68	0,033	7,62	0,05	0,88	0,378	2,321	< 0,001
Al	0,06	0,003	0,07	0,003	-3,46	< 0,001	1,285	0,314
Ammonia nitrogen	0,14	0,01	0,14	0,008	0,11	0,910	2,164	0,002
Nitrates	1,94	0,39	3,37	0,43	-2,44	0,016	1,211	0,442
Oxidation	3,73	0,19	3,00	0,21	2,47	0,015	1,201	0,463

Analysis of diseases of population in the control and experimental districts. The results of our data show that during last 5 years there is a probable increase in the incidence of diseases of circulatory system with the highest level in Vozdvyzhivskyi (4652.17 cases per 100 000 population), Komsomolskyi (3071.97 cases) and Novozlatopilskyi (4596.91 cases) hospital districts ($p < 0.001$). The incidence of diseases of circulatory system in these hospital districts exceeds average level in Huliaipilskyi district (3048.56 cases per 100 000 population) in 1.53, 1.01 and 1.51 times, respectively.

The probably high incidence of hypertensive disease (HD) was registered in Vozdvyzhivskyi, Komsomolskyi, Novozlatopilskyi and Uspenivskyi districts ($p < 0.001$). Incidence of coronary heart disease (CHD) per 100000 population was shown on the level (588.6 cases) in the control district – Huliaipilskyi against experimental districts – Vozdvyzhivskyi (1026.92 cases); Komsomolskyi (616.96 cases); Novozlatopilskyi (1428.46 cases); Uspenivskyi (659.78 cases) and Malynivskyi (1137.42 cases) hospital districts. Thus, there is a probable increase for this class of diseases among adult population in the relevant hospital areas on 1.74; 1.05; 2.43; 1.12 and 1.93 times ($p < 0.001$).

Probably high incidence of kidney stones and urinary tract diseases was registered only on two hospital districts: Vozdvyzhivskyi (87.66 cases) and Komsomolskyi (179.9 cases) on the background of (69.6 cases per 100 000 population) in Huliaipilskyi district ($p < 0.001$). There is shown increase of incidence for this class of diseases among adult population in Vozdvyzhivskyi and Komsomolskyi hospital districts on 1.26 and 2.58 times, respectively.

There was a probable increase prevalence of diseases of circulatory system in the Uspenivskyi (37002.87 cases) and Malynivskyi (39375.45 cases) hospital districts, which exceeds average level (36757.75 cases per 100 000 population) on 1.01 and 1.07 times ($p < 0.001$).

Increasing prevalence of HD was found in the territory of Uspenivskyi (18571.69 cases) on 1.02 times and Malynivskyi on 1.15 times (20980.25 cases) hospital districts against (18149.8 cases) in the Huliaipilskyi district. The prevalence of coronary heart disease per 100 000 of adult population was: in Novozlatopilskyi (10090.41 cases) and Uspenivskyi (12535.89 cases) hospital districts against (7921 cases) in Huliaipilskyi rural district. There is a probable increase in the prevalence this class of diseases compared with an intensive rate in the Huliaipilskyi district (on 1.27 and 1.58 times).

Probably high level of prevalence the kidney stones and urinary tract diseases was registered in Komsomolskyi (179.9 cases per 100 000 population), Novozlatopilskyi (205.15 cases) and Uspenivskyi (213.81 cases) hospital districts against (145.7 cases) in the Huliaipilskyi district. The increased prevalence this class of diseases in the Komsomolskyi, Novozlatopilskyi and Uspenivskyi hospital districts was 1.23, 1.41 and 1.47 times, respectively ($p < 0.001$).

The low level prevalence of all classes of diseases was registered in the territory of Huliaipilskyi, Vozdvyzhivskyi and Komsomolskyi hospital districts, except the prevalence of kidney stones and urinary tract diseases.

Compared with prevalence diseases of the circulatory system among the adult population in Huliaipilskyi district, this class of diseases is also characterized by the dynamics of growth at the population of city Hulyaipillia during 2015–2019 years. In the city Hulyaipillia was shown increased prevalence diseases of the circulatory system: in 2016 year 3.73 $\%_{000}$ (against 3.01 $\%_{000}$); in 2017 – 4.15 $\%_{000}$; in 2018 – 2.54 $\%_{000}$ and in 2019 – 4.20 $\%_{000}$.

We calculated indicators of relative risk (RR) of health disorders according to the levels of disease in the five experimental districts, where population consumed drinking water from decentralized water supply systems (tab. 2).

Table 2

Indicators of relative risk of disease among population in the experimental districts

Classes of diseases	Water quality indicators	Relative risk *(RR)**	95 % CI
III. Diseases of blood and hematopoietic organs	pH	4,27	3,50–5,04
III. Anemia	Cu	2,99	2,07–3,92
	pH	4,27	3,50–5,03
IX. Diseases of circulatory system	Fe	2,50	1,60–3,41
XI. Diseases of digestive system	Cu	4,03	3,02–5,03
XIII. Diseases of the musculoskeletal system	pH	2,04	1,34–2,75
	nitrites	3,82	2,26–5,39
XVII. Congenital anomalies	pH	3,05	2,34–3,76
XVII. Congenital anomalies of the circulatory system	chlorides	1,90	1,16–2,65
	Mn	7,60	5,42–9,78

**At the level of p < 0,05*

CONCLUSIONS

1. Results of our study allowed to establish the most informative indicators with the highest values of relative risk factors, which are primarily respond to changes in the salt and chemical composition of drinking water from decentralized water supply systems in the five experimental districts are the following marker nosologies: diseases of the blood and hematopoietic organs ($RR = 4.27$, $p < 0.05$), anemia ($RR = 4.27$, $p < 0.05$), diseases of the circulatory system ($RR = 2.50$, $p < 0.05$), digestive organs ($RR = 4.03$, $p < 0.05$), muscularskeletal system ($RR = 3.82$, $p < 0.05$), congenital anomalies ($RR = 3.05$, $p < 0.05$), congenital anomalies of the circulatory system ($RR = 7.60$, $p < 0.05$).

2. There is shown a probably lower level of morbidity on some nosological forms among adult population in Huliaipilskyi control district: diseases of the circulatory system (2626.17 cases); hypertension (1250.16 cases); coronary heart disease (428.44 cases), kidney stones and urinary tract diseases (38.60 cases per 10 000 population) ($p < 0.001$). On our opinion, the population of control region consume for the last 5 years of observation (2015–2019) drinking water from centralized systems, which is constantly control by sanitary service.

3. It was established that a high level prevalence of kidney stones and diseases of the urinary system, diseases of the circulatory system, hypertension, coronary heart disease was shown in the territory of experimental rural districts among adult population, compared with average annual indicator in the Hulyaipilskyi control district *($p < 0.001$).* We consider that it is connected with constant using of drinking water from the public and private wells during 2015–2019 years, which were not control by sanitary inspection of the region.

4. It was established that incidence rate per 100 000 population exceeded average district and regional average levels for the disease of III, XIV classes in Vozdvyzhivskyi, Komsomolskyi and Novozlatopilskyi hospital districts. During period from 2015 to 2019 years there is shown a probable increase prevalence of diseases in Novozlatopilskyi, Uspenivskyi and Malynivskyi hospital districts (by the III, XIV classes of diseases) *($p < 0.001$).*

PROSPECTS FOR FUTURE STUDIES

Further study of influence of chemical composition of drinking water on the state of health of population living in the rural settlements is promising. Because Ukraine takes one of the first places in Europe by the level of morbidity of such diseases as circulatory system, coronary heart disease and hypertension illness in the adult population.

CONFLICT OF INTEREST

Conflict of interest: is absent.

RESEARCH WORK

Research work was carried out within a framework on the cathedral theme of the research work: «Hygienic assessment influence of the natural and technogenic factors on the public health», state registration number 0118U004729 (implementation period 2019–2022 years).

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ВПЛИВ ЯКОСТІ ПИТНОЇ ВОДИ НА ЗДОРОВ'Я НАСЕЛЕННЯ У ГУЛЯЙПІЛЬСЬКОМУ СІЛЬСЬКОМУ РАЙОНІ

Григоренко Л. В.

Вступ. Представлені нами дані характеризують пріоритетні в сфері питного водопостачання проблеми якості питної води, актуальні для багатьох регіонів України, в тому числі і для Гуляйпільського району Запорізької області, населення якого отримує питну воду з відхиленнями за окремими показниками від гігієнічних нормативів.

Мета. Вивчити вплив мінерального складу питної води на стан здоров'я населення у п'яти експериментальних районах (Воздвиженський, Комсомольський, Новозлатівський, Успенівський та Малинівський) Запорізької області, порівняно з контрольним Гуляйпільським районом (з найнижчим рівнем захворюваності серед населення).

Матеріали та методи. Вивчення якості питної води з централізованих та децентралізованих джерел водопостачання Гуляйпільського району (всього 102 дослідження). Показники загальної та первинної захворюваності серед дорослого населення Гуляйпільського району були вивчені за останні 5 років (загалом 280 досліджень). Показники загальної та первинної захворюваності серед дорослого населення в окремих госпітальних округах були проаналізовані відповідно до медичної документації (всього 350 досліджень).

Результати. Встановлено відхилення якісного складу питної води з підвищенням рівня загальної мінералізації на протязі 2015–2019 рр. на території окремих сільських дільниць: від 1,15 до 21,28 разів. Виявлено достовірно високий рівень розповсюдженості каменів нирок і сечоводів, хвороб системи кровообігу, гіпертонічної хвороби, ішемічної хвороби серця на територіях лікарняних амбулаторій: Комсомольської, Новозлатопольської, Успенської і Малинівської, у порівнянні з середньорічними показниками у Гуляйпільському районі ($p < 0,001$).

Висновки. Виявлена тенденція до збільшення захворюваності на гіпертонічну хворобу в усіх сільських районних амбулаторіях за 2015–2019 річний період. Виявлено статистично значущі кореляційні залежності середньої сили між окремими компонентами мінерального складу питної води: жорсткість, сухий залишок, загальна мінералізація і розповсюдженістю захворювань III, XIV класів хвороб за МКХ-10 *($r = 0,30, p < 0,05$).*

КЛЮЧОВІ СЛОВА: сільські райони, питна вода, середньорічний показник, мінеральний склад, III, XIV класи захворювань

ІНФОРМАЦІЯ ПРО АВТОРА

Григоренко Любов Вікторівна, д.мед.н., доцент кафедри гігієни, екології та охорони праці, ДУ «Дніпропетровська медична академія МОЗ України», Соборна площа, 2, Дніпро, Україна, 49027, email: hryhorenkoluibov@ukr.net, ORCID ID; https: //orcid.org/0000-0002-9517-5975

ВЛИЯНИЕ КАЧЕСТВА ПИТЬЕВОЙ ВОДЫ НА ЗДОРОВЬЕ НАСЕЛЕНИЯ В ГУЛЯЙПОЛЬСКОМ СЕЛЬСКОМ РАЙОНЕ

Григоренко Л. В.

Введение. Представленные нами данные характеризуют приоритетные в сфере питьевого водоснабжения проблемы водоснабжения и качества питьевой воды, актуальные для многих регионов Украины, в том числе и для Гуляйпольского района Запорожской области, население которого получает питьевую воду с отклонениями по отдельным показателям от гигиенических нормативов.

Цель. Изучить влияние минерального состава питьевой воды на состояние здоровья населения в пяти экспериментальных районах (Воздвиженский, Комсомольский, Новозлатовский, Успеновский и Малиновский) Запорожской области, по сравнению с контрольным Гуляйпольским районом (с низким уровнем заболеваемости среди населения).

Материалы и методы. Изучение качества питьевой воды из централизованных и децентрализованных источников водоснабжения Гуляйпольского района (всего 102 исследования). Показатели общей и первичной заболеваемости среди взрослого населения Гуляйпольского района были изучены за последние 5 лет (всего 280 исследований). Показатели общей и первичной заболеваемости среди взрослого населения в отдельных госпитальных округах были проанализированы в соответствии с медицинской документацией (всего 350 исследований).

Результаты. Установлено отклонение качественного состава питьевой воды с повышением уровня общей минерализации в течение 2015–2019 гг. На территории отдельных сельских участков от 1,15 до

21,28 раз. Выявлено достоверно высокий уровень распространённости камней почек и мочеточников, болезней системы кровообращения, гипертонической болезни, ишемической болезни сердца на территориях больничных амбулаторий: Комсомольской, Новозлатопольской, Успенской и Малиновской, по сравнению со среднегодовыми показателями в Гуляйпольском районе ($p < 0,001$).

Выводы. Выявлена тенденция к увеличению заболеваемости гипертонической болезнью во всех сельских районных поликлиниках за 2015–2019 летний период. Выявлено статистически значимые корреляционные зависимости средней силы между отдельными компонентами минерального состава питьевой воды: жёсткость, сухой остаток, общая минерализация и распространённостью заболеваний III, XIV классов болезней по МКБ-10 ($r\ 0,30, p < 0,05$).

КЛЮЧЕВЫЕ СЛОВА: сельские районы, питьевая вода, среднегодовой показатель, минеральный состав, III, XIV классы заболеваний

ИНФОРМАЦИЯ ОБ АВТОРЕ

Григоренко Любовь Викторовна, д.мед.н., доцент кафедры гигиены, экологии и охраны труда, ГУ «Днепропетровская медицинская академия МЗ Украины», Соборная площадь, 2, Днепр, Украина, 49027,email: hryhorenkoluibov@ukr.net , https://orcid.org/0000-0002-9517-5975