UDC 614.777:614.2(574)
DOI 10.59598/ME-2305-6053-2026-119-2-45-53

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MEDICAL AND SOCIAL CHALLENGES OF SAFELY MANAGED WATER SUPPLY IN KAZAKHSTAN

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Drinking water quality remains one of the key determinants of public health and sanitary-epidemiological well-being. Despite the progress with access to centralized water supply systems in the Republic of Kazakhstan, several medical and social challenges remain, including unequal access to safe drinking water, particularly in rural areas, deteriorating infrastructure, contamination of surface and groundwater sources, and insufficient efficiency of water treatment and quality monitoring systems.

The aim of this review was to analyze current scientific data on the major issues of drinking water supply and the impact of water quality on public health in Kazakhstan. This review used a combined approach, including the analysis of scientific literature, international reports and official statistical data. Searches were conducted using the PubMed, Scopus, Web of Science, eLibrary, and Google Scholar databases, as well as official websites of the WHO, UNICEF, the World Bank, and governmental authorities of the Republic of Kazakhstan. A total of 38 sources were included in the review. The findings indicate that drinking water in several regions of Kazakhstan exceeds permissible limits for certain chemical parameters, including nitrates, arsenic, lead, iron and mercury, due to both natural geochemical characteristics and anthropogenic impacts. Cases of microbiological contamination have also been reported, particularly in rural areas and during flood periods. Potential risks associated with both conventional and emerging contaminants, including PFAS and microplastics, are analyzed. Long-term consumption of contaminated water is associated with an increased risk of infectious, cardiovascular, oncological, nephrological, and reproductive disorders, especially among vulnerable population groups. A comparative analysis of drinking water quality standards in the Republic of Kazakhstan, the WHO, and the EU revealed that national regulations are less stringent for certain carcinogenic substances. The findings highlight the need to modernize water supply infrastructure, improve the regulatory framework, strengthen laboratory monitoring, and implement advanced water treatment technologies to ensure access to safe drinking water for the population of Kazakhstan.

Key words: water quality; drinking water; water supply; public health; contaminants; epidemiology

INTRODUCTION

Drinking water is a key indicator of population health and development. According to the World Health Organization (WHO), more than two billion people worldwide use water that does not meet sanitary standards [1, 2]. This contributes to a substantial burden of infectious diseases (acute intestinal infections and viral hepatitis), as well as an increased incidence of chronic diseases associated with the chemical composition of drinking water. In response, the United Nations identified ensuring safely managed drinking water for all by 2030 as one of the priorities of Sustainable Development Goal 6 (SDG 6). In Kazakhstan, as in many other countries, the quality of drinking water supply remains problematic. Despite abundant surface water resources (48,000 lakes and over 85,000 rivers) [3], a lack of truly clean water is observed across the country [4].

For the Republic of Kazakhstan, the implementation of SDG 6 is of strategic importance due to limited water resources, high dependence on transboundary rivers, and the need to ensure sanitary and epidemiological safety of the population [5]. In recent years, significant progress has been achieved in expanding population access to water supply services [6]. According to World Bank data, approximately 90% of the population of Kazakhstan has access to safely managed drinking water sources; however, this indicator is about 60% in rural areas [2, 3, 7]. One of the key challenges remains the unequal access to cen-

Table 1 – Drinking water quality standards according to WHO, EU, and Kazakhstan regulations (MPC, mg/L) [13, 15, 16, 17, 18]

Parameter	WHO	EU	Kazakhstan
Arsenic (As)	0.02 mg/L [6]	0.01 mg/L [6]	0.05 mg/L [13]
Nitrate (NO_3)	50 mg/L [15]	50 mg/L [15]	45 mg/L [13]
Lead (Pb)	0.01 mg/L [18]	0.01 mg/L [18]	0.03 mg/L [13]
E. coli	Absent [17]	Absent [17]	Absent [17]
Thermotolerant coliform bacteria	Absent [17]	Absent [17]	Absent [17]

tralized water supply systems, particularly in rural settlements [8]. State programs aimed at the construction and modernization of water supply networks in rural areas are being consistently implemented [5, 9]. An important component of SDG 6 is the improvement of water quality and the development of monitoring systems. In Kazakhstan, state sanitary and hygienic control of drinking water quality is carried out, along with environmental monitoring of surface and groundwater bodies. However, some water bodies remain exposed to anthropogenic contamination [4], which requires further improvement of laboratory monitoring and the introduction of advanced water treatment technologies [7]. In several regions, projects aimed at reconstructing wastewater treatment facilities are being implemented; however, the level of wastewater treatment remains insufficient and requires additional investment and the adoption of modern technologies [10]. Kazakhstan continues to face regional disparities in access to safe drinking water, deterioration of infrastructure, contamination of water sources, and the need to improve wastewater treatment efficiency [4]. These data highlight the relevance of scientific studies focused on assessing drinking water quality and its impact on human health.

This review aims to analyze current scientific evidence on the medical and social challenges associated with drinking water supply in Kazakhstan.

SEARCH STRATEGY

This study used a combined approach, with a systematic literature review and analysis of official data sources. The search strategy included the Scopus, PubMed, eLibrary, Web of Science, and Google Scholar databases, as well as the official websites of UNICEF, WHO, the World Bank, the Ministry of Health of the Republic of Kazakhstan, the Water Resources Agency of the Republic of Kazakhstan, and the Committee for Sanitary and Epidemiological Control. Inclusion criteria comprised full-text, open-access peer-reviewed scientific articles in Russian and English containing the following keywords: «drinking water supply in Kazakhstan», «drinking water quality», «water contamination and health», and «drinking water standards». Exclusion criteria included abstracts, closed-access publications, and non-peer-reviewed sources. Priority was given to primary sources (regulatory documents and official sources) and authoritative international reports (WHO, UNICEF). A total of 38 sources that met the inclusion criteria were selected.

Challenges in Drinking Water Quality Management

According to WHO and UNICEF data (JMP, 2022), approximately 90% of the population of Kazakhstan use safely managed drinking water sources (an increase from 80% since 2015) [2]. However, this indicator remains considerably lower in rural areas, at approximately 60% [2, 3, 7]. The unequal distribution of centralized water supply is associated with low population density in rural settlements and deteriorating infrastructure. In addition, despite full coverage by centralized water supply systems, the city of Astana experiences service interruptions due to system deterioration.

According to the Committee for Sanitary and Epidemiological Control, up to 5% of drinking water samples annually do not comply with sanitary standards, with a target compliance level of 0% [11]. The use of unsafe drinking water directly contributes to an increased incidence of gastrointestinal infections, intestinal helminthiases, and protozoal infections, and increases the risk of exposure to carcinogenic and mutagenic compounds [12].

Table 1 presents hygienic standards for drinking water established by WHO, the European Union (EU), and Kazakhstan. According to Order No. DSM-138 of the Minister of Health of the Republic of Kazakhstan dated 24 November 2022 «On Approval of Hygienic Standards for Safety Indicators of Domestic Drinking and Household Water Use», the maximum permissible concentrations for lead and arsenic are set at 0.03 mg/L and 0.05 mg/L, respectively [13], which exceed WHO guideline values [1]. These differences are attributed to environmental conditions and economic factors. At the same time, the permissible nitrate concentration in Kazakhstan (45 mg/L) [14] is more stringent than WHO/EU standards (50 mg/L) [1, 13, 15].

National standards in Kazakhstan for certain heavy metals (As and Pb) are less stringent than those of the WHO and the EU, reflecting a balance between technological capabilities and economics. Risk

management requires the implementation of Water Safety Plans, which include risk identification at each stage of the water supply and monitoring of key indicators. Quantitative assessment relies on statistical and threshold-based methods, such as the analysis of correlations between diarrhoea cases and levels of faecal coliforms in water samples. In the case of emerging contaminants (PFAS and microplastics), [19, 20] the «precautionary» principle is applied: currently, there are no established maximum permissible concentrations for these substances; however, it is recommended to reduce their levels based on evidence of toxicological effects [17, 19, 21]. In Kazakhstan, the «Water Strategy of the Republic of Kazakhstan until 2030» provides for the modernization of water supply systems and wastewater treatment facilities, including the rehabilitation of outdated water sources, prohibition of untreated wastewater discharge (with strengthened oversight by the Water Resources Agency), and laboratory monitoring of water quality in high-risk areas [9, 17]. However, it is necessary to improve public awareness regarding water hygiene practices, as well as to support vaccination programmes and integrate water-related risk assessment into epidemiological surveillance.

Drinking Water Quality Indicators

Microbiological indicators. According to the sanitary rules and standards, drinking water must be free of Escherichia coli, sulphite-reducing clostridia, and thermotolerant coliform bacteria (per 100 mL) [13, 17, 18]. Despite this requirement, cases of bacterial contamination of drinking water are still reported in rural areas. For example, during spring flood periods in 2022 – 2023, an increase in cases of salmonellosis and dysentery was observed in several regions, associated with the intrusion of wastewater into drinking water sources [22].

Bacterial contamination is particularly high in unprotected wells and open reservoirs. Up to 17% of well water samples contained total coliform bacteria in studies conducted in neighboring regions of Russia [23, 24] which may also reflect the situation in remote northern regions of Kazakhstan. According to epidemiological studies, waterborne pathogenic microorganisms account for approximately 80% of all gastrointestinal infectious diseases in Kazakhstan and Central Asia [25], indicating a substantial burden on public health.

Physical Characteristics and Contaminants. According to official study data conducted between 2020 and 2024, in rural areas of Pavlodar and Akmola regions of the Republic of Kazakhstan, drinking water was frequently characterized by increased turbidity associated with the presence of mechanical impurities, whereas color parameters generally remained within the established regulatory limits [26]. Elevated fluoride (F) concentrations in southern and mountainous regions, such as Zhambyl and Turkestan regions, are attributed to natural geochemical features and hydrogeological conditions of groundwater formation [27] and are often close to the permissible limit of 1.5 mg/L [13], requiring monitoring for fluorosis. Increasing attention has been paid to microplastics and PFAS [19, 20]. Despite the absence of officially established maximum permissible concentrations, the WHO recommends minimizing PFAS levels and strengthening research on their potential health impacts [17, 19]. Microplastic analysis has revealed microparticles in 90% of samples; however, current evidence regarding their toxicity remains insufficient [21, 28].

Chemical Contaminants. Drinking water in Kazakhstan is characterized by elevated salinity (mineralization and hardness), which is associated with the region's geochemical conditions and transboundary water flows. The main hazardous elements include nitrates, arsenic, lead, and other metals. Nitrates (NO_3) arise primarily from intensive agricultural activities; their maximum permissible concentration is 45 mg/L in Kazakhstan [13] (WHO: 50 mg/L [1, 14, 15]). In some southern regions of Kazakhstan, nitrate concentrations exceed the standards in approximately 30% of groundwater samples. Lead (Pb) enters drinking water primarily through deteriorated water supply systems (old pipelines) and industrial discharges. In Kazakhstan, the permissible limit for lead in drinking water is 0.03 mg/L [13] (WHO: 0.01 mg/L [1, 14, 18]). Arsenic (As) levels are significantly higher in mountainous regions [29]; the national limit is 0.05 mg/L [13] (WHO: 0.01 mg/L [1, 17]). Long-term exposure to arsenic and lead is associated with neurological, oncological, and cardiovascular diseases in the population [26, 29, 30, 31]. In certain regions of the Republic, elevated levels of other heavy metals, including iron (Fe), manganese (Mn), and mercury (Hg), as well as pesticide residues in water sources exceeding regulatory limits, have also been reported [20].

According to studies conducted in 2023 – 2025, exceedances of individual chemical parameters such as lead, arsenic, and nitrates have been identified in several regions of Kazakhstan, indicating regional heterogeneity in water quality [9, 27, 32, 33]. In addition, the study by Zh. Tleuova et al. (2023) [27] demonstrated that groundwater in southern Kazakhstan contains significant concentrations of sulphates, sodium, nitrates, and lead. An analysis of surface waters conducted in 2025 by the Republican State Enterprise **«**Kazhydromet**»** of the Ministry of Ecology and Natural Resources of the Republic of Kazakhstan [34] showed that only four water bodies in the country are classified as Class I water quality, while the majority of rivers are classified as moderately or heavily polluted [35]. Therefore, contamination of drinking water sources with various chemical substances remains a widespread environmental and public health problem.

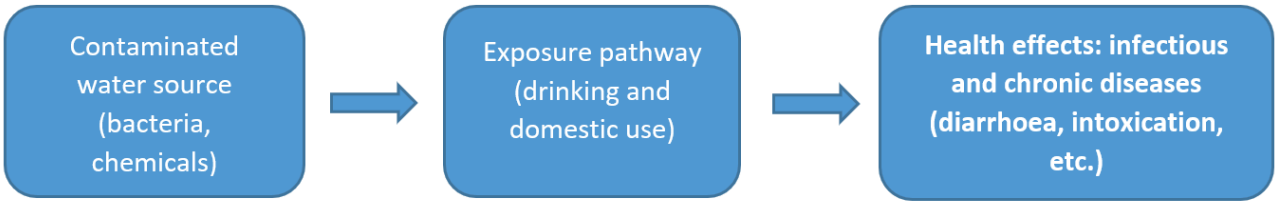

Figure 1 – Mechanism of health effects of contaminated drinking water

Natural Contamination of Water Sources. During floods, drinking water sources become contaminated with sewage and wastewater, leading to outbreaks of diarrhoeal diseases [22]. For example, following the largest flood in East Kazakhstan in 2010, an outbreak of enteroviral infection was recorded. In regions with intensive agriculture, particularly livestock farming, elevated levels of coliphages and nitrates have been observed in groundwater from wells. According to data from the Ministry of Health of the Republic of Kazakhstan, the incidence of intestinal infections typically increases after each emergency situation. This is primarily due to outdated or insufficiently effective water supply and wastewater disposal systems. During outbreaks of waterborne diseases, Giardia and Cryptosporidium are more frequently detected. These pathogens are less sensitive to conventional drinking water and wastewater treatment methods than most bacteria and viruses [36].

Adverse Health Effects of Drinking Water Quality on Population Health

Vulnerable population groups at risk of diarrhoeal diseases associated with the consumption of contaminated water include children, particularly those under the age of 5, pregnant women, low-income populations, and elderly individuals [25]. Pregnant women represent one of the most vulnerable population groups to adverse environmental exposures, including heavy metals and chemical compounds. Chronic exposure to lead, arsenic, and other organic contaminants has been shown to exert teratogenic and embryotoxic effects, negatively influencing fetal development [33]. According to studies [33, 37], exposure to these factors is associated with an increased risk of congenital malformations, intrauterine growth restriction, low birth weight, and preterm birth. Toxic substances are able to cross the placental barrier and affect the formation of fetal organs and systems. Residents of rural areas predominantly rely on non-centralized water supply sources (wells, boreholes, and springs) and less frequently have access to water treatment devices, which makes them a vulnerable population group. An additional risk factor is the lack of systematic monitoring of water quality from decentralized sources at the local level. Contaminated drinking water is a source of both acute and chronic diseases. Microorganisms such as *E. coli, Shigella spp.*, and rotaviruses cause diarrhoeal disease, contributing to substantial child mortality (according to WHO, approximately 444,000 children under the age of 5 die annually from diarrhoeal infections worldwide) [25]. Compliance with hygienic standards is an important preventive measure for reducing infectious disease incidence, particularly among children [38]. Long-term exposure to nitrates causes methemoglobinaemia in infants [1, 14, 15]. Chronic lead exposure leads to reduced IQ in children, as well as hypertension and nephrotoxicity in adults. Arsenic exposure is associated with lung and skin cancers, as well as chronic liver diseases [16, 29, 31]. PFAS and microplastics, as emerging contaminants, affect the endocrine and immune systems [17, 20, 21, 30]. However, due to their relatively recent identification, their health impacts require further investigation (Fig. 1).

According to WHO, poor-quality drinking water supply is responsible for approximately 4 million deaths, including those caused by diarrhoeal and parasitic diseases [25]. In Kazakhstan, waterborne infections account for a substantial proportion of morbidity; for example, acute intestinal infections represent a significant share of infectious diseases, accounting for up to 20% of all reported infectious conditions [1, 15]. The actual burden of disease is likely underestimated, as clinical diagnosis often fails to associate chronic symptoms, such as dyspeptic disorders, hypertension, and other pathological conditions, with contaminated drinking water.

CONCLUSIONS

This literature review demonstrates that the quality of drinking water supply in Kazakhstan remains a critical issue. The main challenges include the lack of universal access to safely managed drinking water sources, particularly in rural areas, as well as the continued presence of widespread biological and chemical contaminants in drinking water, contributing to a significant increase in disease incidence [23]. In addition, national sanitary rules and standards are often less stringent than international guidelines [1], indicating the need to revise the regulatory framework, particularly by strengthening permissible limits for carcinogenic substances such as arsenic and lead. These findings highlight the need for several measures, including the modernization of water supply infrastructure, the adoption of advanced water treatment technologies such as reverse osmosis, disinfection, and activated carbon filtration, as well as strengthened monitoring of drinking water quality

[17]. Climatic factors should also be taken into consideration. Floods increase the risk of water contamination, which is especially relevant in the context of global climate change. Regional cooperation within the framework of the Eurasian Economic Commission may also contribute to addressing drinking water supply challenges by facilitating coordinated action for efficient transboundary water use and water resource protection.

Author Contribution:

M. G. Kalishev – conceptualization.

B. K. Koichubekov – methodology.

B. K. Omarkulov – validation.

A. O. Omarova, M. G. Kalishev, B. K. Omarkulov, B. K. Koichubekov, Ye. M. Isakaev – formal analysis.

A. K. Issatayeva – writing (original draft preparation).

A. O. Omarova – writing (review and editing).

All authors have read and agreed to the final version of the manuscript and signed the copyright transfer agreement.

Conflict of interest:

The authors declare no conflict of interest.

Funding:

This research was funded within the framework of the program-targeted funding of the Ministry of Science and Higher Education of the Republic of Kazakhstan (BR28712227: «Development and implementation of high-tech solutions for monitoring, purification, and rational use of water resources in the North Kazakhstan region to ensure public health»).

REFERENCES

1. *Guidelines for drinking-water quality*. Geneva: WHO; 2022: 614.

2. *WHO & UNICEF. 1 in 4 people globally still lack access to safe drinking water.* https://www.who.int/news/item/26-08-2025-1-in-4-people-globally-still-lack-access-to-safe-drinking-water---who--unicef

3. *Качество воды в Казахстане: опубликован список загрязнённых рек и водохранилищ.* https://bes.media/news/eksperti-cacf-predstavili-neuteshitelnuyu-otsenku-kachestva-vodi-v-kazahstane/

4. *Amid record spending on the war millions in Russia still lack clean water.* https://meduza.io/en/feature/2025/11/18/amid-record-spending-on-the-war-millions-in-russia-still-lack-clean-drinking-water

5. *Казахстан присоединяется к Протоколу по проблемам воды и здоровья ЕЭК ООН–ВОЗ/Европа с целью обеспечения безопасного и устойчивого водоснабжения, санитарии и гигиены для всех.* https://unece.org/ru/environment/press/kazakhstan-prisoedinyaetsya-k-protokolu-po-problemam-vody-i-zdorovya-eek-oon

6. *Sustainable Development Goal 6. Clean Water and Sanitation Ensure availability and sustainable management of water and sanitation for all.* https://kazakhstan.un.org/en/sdgs/6/progress.

7. *Progress on household drinking water, sanitation and hygiene 2000-2024: Special focus on inequalities.* https://data.unicef.org/resources/jmp-report-2025/

8. Omarova A., Kalishev M. The status of household and drinking water supply of the rural population of Karaganda region. *Астана медицина-лық журналы.* 2017; 4: 123-128.

9. Krasnopyorova M., Gorlachev I., Kharkin P., Severinenko M., Zheltov D. Study of the Trace Element Composition of Drinking Water in Almaty City and Human Health Risk Assessment. *International Journal of Environmental Research and Public Health*. 2025; 22 (4): 560. https://doi.org/10.3390/ijerph22040560

10. *Постановление Правительства Республики Казахстан от 25 декабря 2024 года №1102 «Об утверждении Национального проекта «Модернизация энергетического и коммунального секторов».* https://adilet.zan.kz/rus/docs/P2400001102

11. *Экологические индикаторы мониторинга и оценки окружающей среды.* https://stat.gov.kz/ru/ecologic-indicators/28428/drinking_water_quality/

12. Omarova A.O., Tussupova K.M., Berndtsson R., Kalishev M.G. Burden of water-related diseases in developing countries. *Наука и здравоохранение.* 2017; 3: 95-109.

13. *Приказ Министра здравоохранения Республики Казахстан от 24 ноября 2022 года №ҚР ДСМ-138 «Об утверждении Гигиенических нормативов показателей безопасности хозяйственно-питьевого и культурно-бытового водопользования».* https://adilet.zan.kz/rus/docs/V2200030713

14. Previous editions of the Guidelines for Drinking-water Quality. https://www.who.int/teams/environment-climate-change-and-health/water-sanitation-and-health/water-safety-and-quality/drinking-water-quality-guidelines/previous-editions

15. Chemical hazards in drinking-water. *Guidelines for drinking-water quality.* Geneva: WHO; 2022: 168-170.

16. *Arsenic in drinking-water: background document*. Geneva: WHO; 2022: 18.

17. *Санитарно-эпидемиологические правила и нормативы. СанПиН 2.1.4.1074-01 «Питьевая вода и водоснабжение населенных мест».* https://files.stroyinf.ru/Data1/9/9742/

18. *Требования к качеству питьевой воды (СанПин 2.1.4.1074-01).* https://water2you.ru/n-docs/pdk_sanpin/

19. PFOS and PFOA in Drinking-water: Background document for development of WHO Guide-

lines for Drinking-water Quality. https://www.who.int/teams/environment-climate-change-and-health/water-sanitation-and-health/chemical-hazards-in-drinking-water/per-and-polyfluoroalkyl-substances

20. *Microplastics in drinking-water.* https://www.who.int/publications/i/item/9789241516198

21. Microplastics in drinking-water. Geneva: WHO; 2019: 124.

22. *Казахстан усилил санэпиднадзор за питьевой водой и пищевыми продуктами в связи со вспышкой кишечной инфекции в Европе.* https://prg.kz/Document/?doc_id=30997462

23. Dudarev A.A., Dushkina E.V., Sladkova Y.N., Alloyarov P.R., Chupakhin V.S., Dorofeyev V.M., Kolesnikova T.A., Fridman K.B., Evengard B., Nilsson L.M. Food and water security issues in Russia II: water security in general population of Russian Arctic, Siberia and Far East, 2000-2011. *Int. J. Circumpolar. Health.* 2013; 72: 22646. https://doi.org/10.3402/ijch.v72i0.22646

24. Frongillo E.A. Intersection of Food Insecurity and Water Insecurity. *J. Nutr.* 2023; 153 (4): 922-923. https://doi.org/10.1016/j.tjnut.2023.02.024

25. Diarrhoeal disease. https://www.who.int/news-room/fact-sheets/detail/diarrhoeal-disease

26. Beisenova R., Tussupova K., Tazitdinova R., Tulegenova S., Rakhymzhan Z., Orkeyeva A., Alkhanova Y., Myrzagaliyeva A., Nugmanov A., Zhupysheva A. Perceived and Physical Quality of Drinking Water in Pavlodar and Akmola Rural Regions of Kazakhstan. *Sustainability*. 2024; 16 (17): 7625. https://doi.org/10.3390/su16177625

27. Tleuova Z., Snow D.D., Mukhamedzhanov M., Ermenbay A. Relation of Hydrogeology and Contaminant Sources to Drinking Water Quality in Southern Kazakhstan. *Water*. 2023; 15 (24): 4240. https://doi.org/10.3390/w15244240

28. Turdiyeva K., Lee W. Comparative analysis and human health risk assessment of contamination with heavy metals of Central Asian rivers. *Heliyon*. 2023; 9 (6): e17112. https://doi.org/10.1016/j.heliyon.2023.e17112

29. Arsenic. https://www.who.int/news-room/fact-sheets/detail/arsenic

30. Exposure to arsenic: a major public health concern. https://www.who.int/publications/i/item/WHO-CED-PHE-EPE-19.4.1

31. Hong Y.S., Song K.H., Chung J.Y. Health effects of chronic arsenic exposure. *J. Prev. Med. Public Health.* 2014; 47 (5): 245-52. https://doi.org/10.3961/jpmph.14.035

32. Sailaukhanuly Y., Azat S., Kunarbekova M., Tovassarov A., Toshtay K., Tauanov Z., Carlsen L., Berndtsson R. Health Risk Assessment of Nitrate in Drinking Water with Potential Source Identification: A Case Study in Almaty, Kazakhstan. *Int. J. Environ. Res. Public Health*. 2023; 21 (1): 55. https://doi.org/10.3390/ijerph21010055

33. Bommarito P.A., Fry R.C. Developmental windows of susceptibility to inorganic arsenic: a survey of current toxicologic and epidemiologic data. *Toxicol. Res. (Camb)*. 2016; 5 (6): 1503-1511. https://doi.org/10.1039/c6tx00234j

34. Republic of Kazakhstan : Climate Change Impacts and Adaptation Measures in the Water, Agriculture and Rangelands sectors https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099062426135027264

35. Amirgaliyev N.A., Madibekov A.S., Normatov I.Sh. About the criteria of estimation of surface water quality of Kazakhstan on the basis of accounting of its natural features. *News of National Academy of Sciences of the Republic of Kazakhstan.* 2019; 4: 188-198. https://doi.org/10.32014/2019.2518-170X.114

36. Omarova A., Tussupova K., Berndtsson R., Kalishev M., Sharapatova K. Protozoan Parasites in Drinking Water: A System Approach for Improved Water, Sanitation and Hygiene in Developing Countries. *Int. J. Environ. Res. Public Health.* 2018; 15 (3): 495. https://doi.org/10.3390/ijerph15030495

37. Exposure to lead: a major public health concern: preventing disease through healthy environments. Geneva: WHO; 2021: 8.

38. Omarova A.O., Tussupova K.M., Berndtsson R., & Kalishev M.G. Medical and social significance of water supply, sanitation and hygiene in human activity. *Вестник Казахского Национального медицинского университета.* 2017; 3: 193-197.

TRANSLITERATION

1. *Guidelines for drinking-water quality*. Geneva: WHO; 2022: 614.

2. *WHO & UNICEF. 1 in 4 people globally still lack access to safe drinking water*. https://www.who.int/news/item/26-08-2025-1-in-4-people-globally-still-lack-access-to-safe-drinking-water---who--unicef

3. *Kachestvo vody v Kazahstane: opublikovan spisok zagrjaznjonnyh rek i vodohranilishh.* https://bes.media/news/eksperti-cacf-predstavili-neuteshitelnuyu-otsenku-kachestva-vodi-v-kazahstane/

4. *Amid record spending on the war millions in Russia still lack clean water.* https://meduza.io/en/feature/2025/11/18/amid-record-spending-on-the-war-millions-in-russia-still-lack-clean-drinking-water

5. *Kazahstan prisoedinjaetsja k Protokolu po problemam vody i zdorov'ja EJeK OON–VOZ/Evropa s cel'ju obespechenija bezopasnogo i ustojchivogo vodosnabzhenija, sanitarii i gigieny dlja vseh.* https://unece.org/ru/environment/press/kazakhstan-prisoedinyaetsya-k-protokolu-po-problemam-vody-i-zdorovya-eek-oon

6. Sustainable Development Goal 6. Clean Water and Sanitation Ensure availability and sustainable management of water and sanitation for all. https://kazakhstan.un.org/en/sdgs/6/progress.

7. *Progress on household drinking water, sanitation and hygiene 2000-2024: Special focus on inequalities.* https://data.unicef.org/resources/jmp-report-2025/

8. Omarova A., Kalishev M. The status of household and drinking water supply of the rural population of Karaganda region. *Астана медицина-лық журналы.* 2017; 4: 123-128.

9. Krasnopyorova M., Gorlachev I., Kharkin P., Severinenko M., Zheltov D. Study of the Trace Element Composition of Drinking Water in Almaty City and Human Health Risk Assessment. *International Journal of Environmental Research and Public Health.* 2025; 22 (4): 560. https://doi.org/10.3390/ijerph22040560

10. Postanovlenie Pravitel'stva Respubliki Kazahstan ot 25 dekabrja 2024 goda №1102 «Ob utverzhdenii Nacional'nogo proekta «Modernizacija jenergeticheskogo i kommunal'nogo sektorov». https://adilet.zan.kz/rus/docs/P2400001102

11. Jekologicheskie indikatory monitoringa i ocenki okruzhajushhej sredy. https://stat.gov.kz/ru/ecologic-indicators/28428/drinking_water_quality/

12. Omarova A.O., Tussupova K.M., Berndtsson R., Kalishev M.G. Burden of water-related diseases in developing countries. *Наука и здравоохранение*. 2017; 3: 95-109.

13. Prikaz Ministra zdravoohranenija Respubliki Kazahstan ot 24 nojabrja 2022 goda №ҚR DSM-138 «Ob utverzhdenii Gigienicheskih normativov pokazatelej bezopasnosti hozjajstvenno-pit'evogo i kul'turno-bytovogo vodopol'zovanija». https://adilet.zan.kz/rus/docs/V2200030713

14. *Previous editions of the Guidelines for Drinking-water Quality.* https://www.who.int/teams/environment-climate-change-and-health/water-sanitation-and-health/water-safety-and-quality/drinking-water-quality-guidelines/previous-editions

15. Chemical hazards in drinking-water. *Guidelines for drinking-water quality*. Geneva: WHO; 2022: 168-170.

16. *Arsenic in drinking-water: background document*. Geneva: WHO; 2022: 18.

17. *Sanitarno-jepidemiologicheskie pravila i normativy. SanPiN 2.1.4.1074-01 «Pit'evaja voda i vodosnabzhenie naselennyh mest».* https://files.stroyinf.ru/Data1/9/9742/

18. *Trebovanija k kachestvu pit'evoj vody (SanPin 2.1.4.1074-01).* https://water2you.ru/n-docs/pdk_sanpin/

19. *PFOS and PFOA in Drinking-water: Background document for development of WHO Guidelines for Drinking-water Quality.* https://www.who.int/teams/environment-climate-change-and-health/water-sanitation-and-health/chemical-hazards-in-drinking-water/per-and-polyfluoroalkyl-substances

20. *Microplastics in drinking-water.* https://www.who.int/publications/i/item/9789241516198

21. *Microplastics in drinking-water*. Geneva: WHO; 2019: 124.

22. *Kazahstan usilil sanjepidnadzor za pit'evoj vodoj i pishhevymi produktami v svjazi so vspyshkoj kishechnoj infekcii v Evrope*. https://prg.kz/Document/?doc_id=30997462

23. Dudarev A.A., Dushkina E.V., Sladkova Y.N., Alloyarov P.R., Chupakhin V.S., Dorofeyev V.M., Kolesnikova T.A., Fridman K.B., Evengard B., Nilsson L.M. Food and water security issues in Russia II: water security in general population of Russian Arctic, Siberia and Far East, 2000-2011. *Int. J. Circumpolar. Health.* 2013; 72: 22646. https://doi.org/10.3402/ijch.v72i0.22646

24. Frongillo E.A. Intersection of Food Insecurity and Water Insecurity. *J. Nutr.* 2023; 153 (4): 922-923. https://doi.org/10.1016/j.tjnut.2023.02.024

25. Diarrhoeal disease. https://www.who.int/news-room/fact-sheets/detail/diarrhoeal-disease

26. Beisenova R., Tussupova K., Tazitdinova R., Tulegenova S., Rakhymzhan Z., Orkeyeva A., Alkhanova Y., Myrzagaliyeva A., Nugmanov A., Zhupysheva A. Perceived and Physical Quality of Drinking Water in Pavlodar and Akmola Rural Regions of Kazakhstan. *Sustainability*. 2024; 16 (17): 7625. https://doi.org/10.3390/su16177625

27. Tleuova Z., Snow D.D., Mukhamedzhanov M., Ermenbay A. Relation of Hydrogeology and Contaminant Sources to Drinking Water Quality in Southern Kazakhstan. *Water*. 2023; 15 (24): 4240. https://doi.org/10.3390/w15244240

28. Turdiyeva K., Lee W. Comparative analysis and human health risk assessment of contamination with heavy metals of Central Asian rivers. *Heliyon*. 2023; 9 (6): e17112. https://doi.org/10.1016/j.heliyon.2023.e17112

29. *Arsenic*. https://www.who.int/news-room/fact-sheets/detail/arsenic

30. *Exposure to arsenic: a major public health concern*. https://www.who.int/publications/i/item/WHO-CED-PHE-EPE-19.4.1

31. Hong Y.S., Song K.H., Chung J.Y. Health effects of chronic arsenic exposure. *J. Prev. Med. Public Health.* 2014; 47 (5): 245-52. https://doi.org/10.3961/jpmph.14.035

32. Sailaukhanuly Y., Azat S., Kunarbekova M., Tovassarov A., Toshtay K., Tauanov Z., Carlsen L., Berndtsson R. Health Risk Assessment of Nitrate in Drinking Water with Potential Source Identification: A Case Study in Almaty, Kazakhstan. *Int. J. Environ. Res. Public Health*. 2023; 21 (1): 55. https://doi.org/10.3390/ijerph21010055

33. Bommarito P.A., Fry R.C. Developmental windows of susceptibility to inorganic arsenic: a survey of current toxicologic and epidemiologic data. *Toxicol. Res. (Camb).* 2016; 5 (6): 1503-1511. https://doi.org/10.1039/c6tx00234j

34. Republic of Kazakhstan : Climate Change Impacts and Adaptation Measures in the Water,

Agriculture and Rangelands sectors https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099062426135027264

35. Amirgaliyev N.A., Madibekov A.S., Normatov I.Sh. About the criteria of estimation of surface water quality of Kazakhstan on the basis of accounting of its natural features. *News of National Academy of Sciences of the Republic of Kazakhstan*. 2019; 4: 188-198. https://doi.org/10.32014/2019.2518-170X.114

36. Omarova A., Tussupova K., Berndtsson R., Kalishev M., Sharapatova K. Protozoan Parasites in Drinking Water: A System Approach for Improved Water, Sanitation and Hygiene in Developing Countries. *Int. J. Environ. Res. Public Health.* 2018; 15 (3): 495. https://doi.org/10.3390/ijerph15030495

37. Exposure to lead: a major public health concern: preventing disease through healthy environments. Geneva: WHO; 2021: 8.

38. Omarova A.O., Tussupova K.M., Berndtsson R., & Kalishev M.G. Medical and social significance of water supply, sanitation and hygiene in human activity. *Вестник Казахского Национального медицинского университета.* 2017; 3: 193-197.

Received 11.09.2025
Sent for revision 22.11.2025
Accepted 08.01.2026
Published online 30.06.2026

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МЕДИКО-СОЦИАЛЬНЫЕ ПРОБЛЕМЫ ОБЕСПЕЧЕНИЯ БЕЗОПАСНО УПРАВЛЯЕМЫМ ВОДОСНАБЖЕНИЕМ В КАЗАХСТАНЕ

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На сегодняшний день качество питьевой воды является одним из ключевых факторов, отвечающих за состояние здоровья и санитарно-эпидемиологическое благополучие населения. Несмотря на достигнутый прогресс в получении доступа населения Республики Казахстан к централизованному водоснабжению, сохраняются медико-социальные проблемы, связанные с неравномерностью обеспечения безопасной питьевой водой, в частности в сельских регионах, изношенностью инфраструктуры, загрязнением поверхностных и подземных источников, а также недостаточной эффективностью систем очистки и мониторинга качества воды.

Целью настоящего обзора явился анализ современных научных данных, посвященных актуальным проблемам питьевого водоснабжения и влиянию качества воды на здоровье населения Казахстана. В работе использован комбинированный подход, включающий анализ научной литературы, международных отчетов и официальных статистических данных. Поиск осуществлялся в базах данных PubMed, Scopus, Web of science, eLibrary и Google Scolar, а также на официальных сайтах ВОЗ, UNICEF, Всемирного банка и государственных органов Республики Казахстан. В обзор были включены 38 источника. Установлено, что в отдельных регионах Казахстана сохраняются превышения по ряду химических показателей питьевой воды, включая нитраты, мышьяк, свинец, железо и ртуть, что обусловлено как природно-геохимическими особенностями, так и антропогенным воздействием. Отмечаются случаи микробиологического загрязнения воды, особенно в сельской местности и в периоды паводков. Рассмотрены потенциальные риски воздействия традиционных и новых загрязнителей, включая PFAS и микропластик. Показано, что длительное потребление загрязненной воды ассоциировано с повышением риска инфекционных, сердечно-сосудистых, онкологических, нефрологических и репродуктивных нарушений, особенно среди уязвимых групп населения. Проведен сравнительный анализ нормативов качества питьевой воды Республики Казахстан, ВОЗ и ЕС, выявивший менее строгие отечественные требования по отдельным канцерогенным веществам. Полученные данные подчеркивают необходимость модернизации систем водоснабжения, совершенствования нормативно-правовой базы, усиления лабораторного мониторинга и внедрения современных технологий водоочистки для обеспечения населения Казахстана безопасной питьевой водой.

Ключевые слова: качество воды; питьевая вода; водоснабжение; здоровье населения; загрязнители; эпидемиология

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ҚАЗАҚСТАНДА ҚАУІПСІЗ БАСҚАРЫЛАТЫН СУМЕН ҚАМТАМАСЫЗ ЕТУДІҢ МЕДИКО-ӘЛЕУМЕТТІК МӘСЕЛЕЛЕРІ

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Бүгінгі таңда ауыз судың сапасы халықтың денсаулығы мен санитарлық-эпидемиологиялық әл-ауқатына жауап беретін негізгі факторлардың бірі болып табылады. Қазақстан Республикасы халқының орталықтандырылған сумен жабдықтауға қол жеткізудегі қол жеткізген жетістіктеріне қарамастан, атап айтқанда, ауылдық өңірлерде қауіпсіз ауыз сумен қамтамасыз етудің біркелкі еместігіне, инфрақұрылымның тозуына, жер үсті және жер асты көздерінің ластануына, сондай-ақ су сапасын тазарту және мониторингілеу жүйелерінің тиімділігінің жеткіліксіздігіне байланысты медико-әлеуметтік мәселелер сақталуда.

Осы шолудың мақсаты ауыз сумен жабдықтаудың өзекті мәселелеріне және су сапасының Қазақстан халқының денсаулығына әсеріне арналған қазіргі заманғы ғылыми деректерді талдау болды. Жұмыста ғылыми әдебиеттерді, халықаралық есептерді және ресми статистикалық деректерді талдауды қамтитын аралас тәсіл қолданылды. Іздеу PubMed, Scopus, Web of science, eLibrary және Google Scolar дерекқорларында, сондай-ақ ДДҰ, UNICEF, Дүниежүзілік банк және Қазақстан Республикасы мемлекеттік органдарының ресми сайттарында жүзеге асырылды. Шолу 38 дереккөзді қамтыды. Қазақстанның жекелеген өңірлерінде нитраттар, мышьяк, қорғасын, темір және сынапты қоса алғанда, табиғи-геохимиялық ерекшеліктерімен де, антропогендік әсерімен де байланысты ауыз судың бірқатар химиялық көрсеткіштері бойынша асып кетулер сақталатыны анықталды. Судың микробиологиялық ластану жағдайлары, әсіресе ауылдық жерлерде және су тасқыны кезінде байқалады. Дәстүрлі және жаңа ластаушы заттардың, соның ішінде PFAS және микропластиктердің әсер ету қаупі қарастырылады. Ластанған суды ұзақ уақыт тұтыну инфекциялық, жүрек-қан тамырлары, онкологиялық, нефрологиялық және репродуктивті бұзылулар қаупінің жоғарылауымен байланысты, әсіресе халықтың осал топтары арасында. Жекелеген канцерогенді заттар бойынша отандық талаптардың қатаңдығын анықтаған Қазақстан Республикасы, ДДҰ және ЕО ауыз суының сапа нормативтеріне салыстырмалы талдау жүргізілді. Алынған деректер Қазақстан халқын қауіпсіз ауыз сумен қамтамасыз ету үшін сумен жабдықтау жүйелерін жаңғырту, нормативтік-құқықтық базаны жетілдіру, зертханалық мониторингті күшейту және су тазартудың заманауи технологияларын енгізу қажеттігін көрсетеді.

Кілт сөздер: судың сапасы; ауыз су; сумен жабдықтау; халықтың денсаулығы; ластаушы заттар; эпидемиология