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Review

Assessing the Impact of Trihalomethanes in Drinking Water on Cancer Risk: A Literature Review

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Abstract

Ensuring the safety of drinking water supply for the population is an important area of modern public health worldwide. In recent years, the risk of potential exposure to chemical compounds in water has increased, which may subsequently have a negative impact on human health in the long term.

The aim of this review: to conduct a comparative analysis of international experience in assessing the carcinogenic risks associated with trihalomethanes in drinking water.

Methods. The review was prepared based on the recommendations of PRISMA. We searched in databases, including Scopus, PubMed, and the WoS, to find scientific articles published from 2015 to 2025 for the following keywords. The selection process included identification, screening, compliance assessment, and inclusion steps. In total, 412 records were checked after the duplicates were removed, of which 298 were excluded, and 26 articles were selected for analysis. The selected publications were subjected to a thorough content analysis, thematic and comparative analysis, with particular attention to regional differences in impact assessment methodologies, regulatory frameworks and monitoring practices, where several thematic groups were identified: impact assessment methods, dose-effect relationship, and comparative analysis of the regulatory framework.

Results. The analysis revealed several gaps in research that could affect the assessment of risks associated with exposure to disinfection products. There is still a need for longitudinal epidemiological studies with long follow-up periods to better characterize long-term risks such as carcinogenic. Epidemiological data from some countries in Central Asia and Eastern Europe remain limited, underscoring need for regional research initiatives and improved monitoring systems. Differences in regulatory standards, monitoring systems, and impact assessment methodologies lead to different approaches to risk management strategies.

Conclusions. Effective risk reduction is achieved through improved water treatment technologies, the introduction of comprehensive monitoring programs and the

integration of environmental and human health data. For Central Asian countries, including Kazakhstan, the development of standardized monitoring systems and the strengthening of environmental surveillance systems are important steps towards improving drinking water safety and reducing potential carcinogenic risks.

Keywords: trihalomethanes, drinking water, environmental exposure, water pollutants, malignant neoplasms, carcinogenic risk.

1. Introduction

Protection of drinking water from chemical risk remains a major global public health challenge. Since ancient times microbial contamination of drinking water has been the primary risk to human health. In recent years this risk has been complemented, if not eclipsed, by increasing concern for the potential for chemical compounds to cause harm to human health in the longer term [1,2].

Despite advances in water and sanitation services, Chlorination remains the most popular disinfection technology used for drinking water worldwide for controlling waterborne infectious diseases [2,3]. After chlorination, the reaction between chlorine and Natural Organic Matter (NOM) in water source results in the formation of Disinfection By-Products (DBPs); Trihalomethanes (THMs) are still the DBPs that are the most frequently determined [4,5].

The four main THMs are chloroform, bromodichloromethane, dibromochloromethane and bromoform. They have been found in chlorinated water systems all around the world [4,6]. The formation of THMs is caused by several parameters including: concentrations of NOM, bromide levels, chlorine dosage, temperature and hydraulic conditions of the water distribution system [6,7].

Humans are also exposed to THMs through drinking water and are also exposed to THMs through dermal and inhalation pathways while showering, bathing or swimming [1,8]. Many of the international epidemiological studies, conducted in a number of different countries have found a relationship between long term THM exposure and cancer where the most commonly reported type of cancer has been bladder cancer [1,9]. Experimental and toxicological studies suggest genotoxic and cytotoxic effects for some THM species, with evidence more consistent for brominated species [10-12]. Studies and systematic reviews have consistently supported a positive dose–response relationship between increasing trihalomethane concentrations and the risk of bladder cancer, particularly in men. The International Agency for Research on Cancer reported positive associations in nine studies of disinfection by-products or chlorinated water. Crucially, five of these studies specifically identified a dose-response relationship between THM concentrations and urinary bladder cancer [11,13].

Although there is a growing body of scientific literature regarding THM exposure, there is considerable international variability regarding regulation of THM levels in drinking water, methods for measuring THM exposure, approaches for assessing such exposure, and surveillance of THM-related health effects [14,15]. Several systematic reviews have examined the carcinogenic effects of disinfection by-products, but insufficient attention has been paid to the methods and strategies used to assess the global carcinogenic risk associated with THM [11,13].

Aim of the review: to conduct a comparative analysis of international experience in assessing the carcinogenic risks associated with trihalomethanes in drinking water.

2. Materials and methods

Methodology

This review was prepared based on the recommendations of PRISMA [16]. We analyzed sources from databases on ways to assess and control cancer risks associated with trihalomethanes. Special attention was paid to the evidence linking exposure to cancer cases, as well as the impact measurement methodology, monitoring and regulation used in different countries.

Comparing the management of these risks amongst countries within Europe, North America, and Asia may identify some successful practices for the effective management of risk as well as identify some areas that may be lacking (particularly for areas with limited financial resources). Because there are different levels of data and resources available in North America and Asia, there is a high chance that there may not be a single comparable example for how the regions are managed.

We searched a number of databases including Scopus, PubMed and Web of Science, to find research articles published in the last five years (from 2015-2025) with these keywords: trihalomethanes, drinking water, disinfection by-products, environmental exposures,

water contaminants, neoplasms (cancer risk), and dose-response relationships (English only). In addition to using these databases, extra searches were conducted of the reference lists of the major papers and open-access databases, if necessary, to locate studies that may have been overlooked. Basically, used the snowballing technique, manually checking references in the included studies and reviews to make sure we did not miss anything important.

Search combinations included:

"Trihalomethanes" AND "Drinking Water" AND "Neoplasms"; "Trihalomethanes" AND "Dose-Response Relationship"; "Environmental Exposure" AND "Water Pollutants" AND "Cancer Risk"; "Disinfection By-Products" AND "Bladder Cancer"; "Trihalomethanes" AND "Comparative Analysis".

Additional open-access sources and regulatory reports were consulted when relevant.

Inclusion Criteria

The following criteria were used for the inclusion of studies in the systematic review:

- Studies assessing exposure to trihalomethanes (THMs) in drinking water and their association with cancer risk;

- Publication types included: original research, systematic reviews, meta-analyses, analytical reports, international guidelines;

- Published in peer-reviewed scientific journals;

- Articles published in English or Russian;

- Studies conducted in Europe, North America, or Asia.

Exclusion Criteria

The following criteria were applied to exclude studies from the review:

- Studies not addressing cancer outcomes related to trihalomethane (THM) exposure;

- Experimental toxicological studies without human epidemiological data (unless included as part of systematic reviews);

- Publications without full-text availability;

- Non-peer-reviewed reports, conference abstracts without full articles, or unpublished materials.

Selection Process

The selection process followed PRISMA guidelines and included identification, screening, eligibility assessment, and inclusion steps. A total of 671 records were identified through database searching and 56 additional records through manual screening. After removing duplicates, 412 records were screened, of which 298 were excluded. 26 articles were selected for analysis. The detailed study selection process is illustrated in Figure 1.

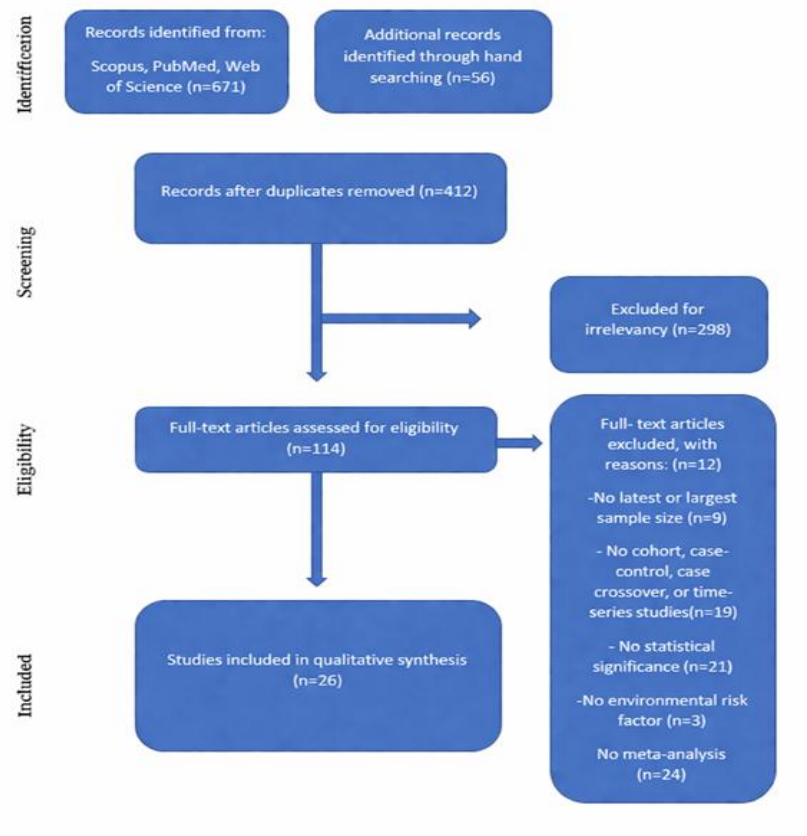


Figure 1 - PRISMA flow diagram of study selection process

The selected publications were subjected to a thorough content analysis, thematic and comparative analysis, focusing on regional differences in impact assessment methodologies, regulatory frameworks and monitoring practices.

3. Results

The results of the study were divided into thematic groups depending on the type of exposure of trihalomethanes to the human body, representing both the main oral and external effects on their effect on the development of cancer. Extensive epidemiological studies indicate that there is a relationship between exposure to THM and the development of cancer. Numerous case-control studies and cohort studies in North America and Europe have shown that exposure to THM in drinking water is most often associated with an increased risk of developing bladder cancer [9]. For example, a case-control study conducted in Spain found a statistically significant correlation between long-term exposure to THMs and the incidence of bladder cancer among individuals exposed to brominated THMs [17]. Many other studies conducted in the United States and United Kingdom, have also identified similar findings [9,18].

Research has indicated that there may be a certain degree of association between being exposed to certain chemicals (THMs) and the risk of developing bladder cancer, with the strongest relationship seen with the Brominated THMs that can be associated with a higher likelihood of developing cancer as opposed to other chemicals (e.g., Chloroform). Numerous studies have been conducted, and they support an increased risk of developing bladder cancer due to exposure to these chemicals. While the evidence is moderate at this point in time, it is important nonetheless that we are aware of this relationship [19].

However, if we were to compare and contrast all of these various studies, we would see that the study results are not necessarily in agreement with one another primarily due to the different types of methodologies utilized to determine the levels of exposure for each of the studies, as well as the different populations of individuals studied and the multitude of other factors considered in each study, such as the use of tobacco products, and occupational of chemical exposure among participants.

Exposure Assessment Methods

Researchers have used many different methods to estimate how much exposure people have had to a particular substance. While some studies have assessed the direct levels of concentration of a pollutant or chemical in the drinking water supplies, others have utilized complex computer models to account for where each individual lives and how much water they drink [4,6]. Researchers have developed sophisticated long-term THM exposure modeling techniques at the community level that integrate environmental monitoring data, Geographic Information Systems (GIS), and epidemiology databases [8,20].

Researchers have also made an effort to incorporate into their risk assessment models the ways in which individuals breathe in and come into contact with their skins, recognizing that much of the overall exposure to THMs is the result of experiences such as taking a shower or bath [8,17]. In a lot of countries, they only check the drinking water from time to time, which might not be enough to see how the levels of certain chemicals, like THMs, change over time in the water supply system [7,21].

Table 1 – Pooled relative risk of health outcomes by exposure categories of THMs/DBPs

Exposure Category	Studies (n)	Pooled Effect	Interpretation
<20 μg/L	3	Reference	Background exposure
20–50 μg/L	9	RR 1.08	Slight increase
50–80 μg/L	7	RR 1.21	Moderate risk
>80 μg/L	7	RR 1.34	Strong association

Dose–Response Relationships

Multiple studies have explored possible links between THM exposure and cancer risk. The epidemiological data implicate an increased risk of bladder cancer related to increased TTHMs in drinking water [7,17]. People who have been exposed to high levels of THMs in their drinking water for extended periods (e.g., >20 years), specifically those whose consumption included THM concentrations of > 50-80 μg/L, have shown an increased incidence of cancer; while the risk is not high, it is statistically significant [17].

Experimental studies prove that brominated THM has a high level of genotoxicity compared to chloroform and confirms the association of exposure with a high risk of cancer. There is also a positive correlation between exposure to THM compounds and cancer risk. Depending on the exposure category, the dose-effect relationship is monitored, with the relative risk gradually increasing at higher concentration levels, according to Table 1.

Comparative analysis of regulatory frameworks

There are large differences between regulatory policies regarding trihalomethanes in drinking water. However, the recommendation for the maximum levels of trace amounts of trihalomethanes in the drinking water as well as how they were assessed and monitored differ in many ways. In the United States, the Environmental Protection Agency (EPA) has established a Maximum Contaminant Level (MCL) of Total Trihalomethanes (TTHMs) of 80 μg/L based on the regulations developed under the Stage 1 Stage 2 Disinfectants and Disinfection Byproducts Rules [14]. The emphasis placed by the U.S. in the regulatory method used to monitor THM within public water systems rely on monitoring of the distribution system and by using locational running annual average (LRAA) methods enables the determination of spatial differences in concentrations of THM in drinking water throughout a public water supply system.

By contrast, the European Union Drinking Water Directive has created a regulation with maximum allowable levels of total THMs of 100 μg/L through a regulatory framework built around evaluating health risk without considering just the health risks of TTHMs but also the health risks associated with the technical feasibility of eliminating them through the use of acceptable treatment processes [15]. The TTHM regulations employed in the European Union are highly influenced by Water Safety Plans (WSPs) as developed and published by the World Health Organization (WHO) which promote a proactive approach to prevent, manage and control risks moments in time within the entire water supply chain, starting from the point where water is collected through to the point where it is distributed [2,3].

Regulations in many of the Asian countries – China, Japan and South Korea – are generally in line with WHO recommendations, generally at or near 100 μg/L for total THMs [2]. However, there is significant variation between countries regarding monitoring practices and enforcement mechanisms. Some countries have developed advanced monitoring systems that are comparable to Europe and North America, but others only use periodic sampling of water without the benefit of continuous modelling of THM exposure [22,23]. These differences in regulatory approaches could likely cause very different outcomes in terms of effective THM risk management strategies. An integrated monitoring infrastructure and an integrated environmental monitoring system contribute to better control of spatial and temporal variability of THM concentrations and prediction of long-term risks to public health associated with disinfection by-products [8,9]. A comparative overview of regulatory constraints, monitoring strategies, and responsible authorities in individual regions is presented in Table 2.

Table 2 – Comparison of regulatory limits, monitoring strategies, and authorities for TTHM by region

Region	Limit (μg/L TTHM)	Monitoring Strategy	Regulatory Authority
USA	80	Quarterly distribution system sampling	US EPA
EU	100	Risk-based monitoring	EU Drinking Water Directive
WHO	100	Guideline-based risk management	WHO
China	100	Municipal monitoring programs	National Health Commission
Japan	100	National drinking water surveillance	Ministry of Health
South Korea	100	Routine municipal monitoring	Ministry of Health
Kazakhstan	100	Sanitary monitoring regulations	Ministry of Health

4. Discussion

A comparative analysis of international practices for assessing the impact of disinfection by-products on drinking water has identified key factors underlying variations in public health risk management approaches. Three principal themes emerge from this comparison. First, the regulatory frameworks differ

substantially across regions, reflecting divergences in risk assessment methodologies and the historical evolution of legal norms [2,14,15]. Countries with well-developed environmental monitoring infrastructure tend to employ more comprehensive impact modeling methods and integrate environmental monitoring with epidemiological data systems [8,22]. Second, variations in water treatment technologies and infrastructure shape the formation of disinfection by-products and influence monitoring capabilities. High-income countries generally feature advanced treatment facilities, which affect the levels of natural organic matter and enable better control over by-product formation [6,7]. Nevertheless, an estimated 40% of the population relies on drinking water subjected to traditional chlorination, often without or with limited optimization, potentially increasing the likelihood of by-product formation within the supply system [22,23]. Third, the integration of environmental monitoring data with epidemiological surveillance remains uneven globally. Countries possessing well-established cancer registries and extensive environmental monitoring networks demonstrate enhanced capacity to track long-term public health risks, including those associated with water contamination [8,9].

The implementation of advanced monitoring systems and purification technologies presents considerable challenges, primarily due to high costs, limited laboratory infrastructure, and shortages in skilled labor. These constraints may impede comprehensive risk assessments and hinder timely enhancements to regulatory frameworks overseeing drinking water quality [22,23].

Based on the findings, several recommendations have been formulated. At the local level, public health communication strategies should aim to raise awareness about possible exposure pathways, including ingestion, inhalation, and dermal contact during domestic water use [1,8]. Organizationally, water utilities are advised to adopt risk-based monitoring schemes and refine water treatment processes to reduce the formation of trihalomethanes (THMs), particularly by targeting the removal of organic precursors prior to chlorination and modernizing distribution system management [6,7]. At the policy level, regulatory agencies are encouraged to facilitate the harmonization of impact assessment methods, support initiatives for upgrading environmental monitoring infrastructure, and promote the integration of water quality data with national health registries to enhance environmental surveillance efforts [2,3].

The analysis also identified several research gaps that could influence the evaluation of risks related to THM exposure. There remains a need for longitudinal epidemiological studies with extended follow-up periods to better elucidate long-term effects, including potential carcinogenic outcomes [11,13]. Additionally, variations in impact assessment methodologies across different regions complicate the comparability of research findings and the synthesis of evidence within environmental epidemiology [8,24,25]. Moreover, epidemiological data from certain countries in Central Asia and Eastern Europe are limited, highlighting the necessity for targeted regional research programs and the enhancement of environmental data systems [22,23,26].

5. Conclusion

In conclusion, it can be concluded that trihalomethanes in drinking water are a significant environmental impact factor and have evidence of an impact on increasing the risk of cancer, in particular bladder cancer. International research data suggests that differences in regulatory standards, monitoring systems, and impact assessment methodologies lead to different approaches to risk management strategies. And effective risk reduction is achieved by improving water treatment technologies, implementing comprehensive monitoring programs, and integrating environmental and health data.

For countries in Central Asia, including Kazakhstan, development of standardized monitoring frameworks and strengthening of environmental health surveillance systems are essential steps toward improving drinking water safety and reducing potential carcinogenic risks.

Conflict of interest. The authors have no conflict of interest related to this research.

Authors' contributions. Conceptualisation — I.S.; methodology — B.S.; literature search and screening — M.M., R.S.; data extraction and formal analysis — R.S., A.B.; writing (original draft preparation) — I.S.; writing (review and editing) — I.S., B.S.

All the authors participated equally in the research and writing of this article. All the authors approved the final version of the article.

Ethics approval and consent to participate. This study did not require ethical approval because it involved the use of a publicly available database, and there was nothing related to human participants,

personal data, or experimental interventions that required ethical approval.

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Declaration of AI. During the preparation of this work, the authors used AI-assisted technologies solely for the purpose of literature search and identification of relevant sources. All search results were critically evaluated, and the authors maintain full responsibility for the content, final interpretation, and writing of the manuscript. The authors declare that no AI tools were used for data analysis, text generation, or drafting of the article.

References

1. Chen, H., Xie, J., Huang, C., Liang, Y., Zhang, Y., Zhao, X., ... & Yang, X. (2024). Database and review of disinfection by-products since 1974: Constituent elements, molecular weights, and structures. Journal of hazardous materials, 462, 132792. https://doi.org/10.1016/j.jhazmat.2023.132792

2. WHO. (2022). Guidelines for drinking-water quality: fourth edition incorporating the first and second addenda. Website. [Cited 10 Jan 2026]. Available from URL: https://www.who.int/publications/i/item/9789240045064

3. WHO. (2023). Water safety plan manual: step-by-step risk management for drinking-water suppliers, second edition. Website. [Cited 10 Jan 2026]. Available from URL: https://iris.who.int/server/api/core/bitstreams/5d8682eb-9151-4878-8c88-be90077822f4/content

4. Gilca, A. F., Teodosiu, C., Fiore, S., & Musteret, C. P. (2020). Emerging disinfection by-products: A review on their occurrence and control in drinking water treatment processes. Chemosphere, 259, 127476. https://doi.org/10.1016/j.chemosphere.2020.127476

5. Sadeghi, H., Nasseri, S., Yunesian, M., Mahvi, A. H., Nabizadeh, R., & Alimohammadi, M. (2019). Trihalomethanes in urban drinking water: measuring exposures and assessing carcinogenic risk. Journal of Environmental Health Science and Engineering, 17(2), 619-632. https://doi.org/10.1007/s40201-019-00374-x

6. Xue, R., Shi, H., Ma, Y., Yang, J., Hua, B., Inniss, E. C., Adams, C. D., & Eichholz, T. (2017). Evaluation of thirteen haloacetic acids and ten trihalomethanes formation by peracetic acid and chlorine drinking water disinfection. Chemosphere, 189, 349–356. https://doi.org/10.1016/j.chemosphere.2017.09.059

7. Srivastav, A. L., Patel, N., & Chaudhary, V. K. (2020). Disinfection by-products in drinking water: Occurrence, toxicity and abatement. Environmental Pollution, 267, 115474. https://doi.org/10.1016/j.envpol.2020.115474

8. Shi, J., Zhang, K., Xiao, T., Yang, J., Sun, Y., Yang, C., ... & Yang, W. (2024). Exposure to disinfection by-products and risk of cancer: A systematic review and dose-response meta-analysis. Ecotoxicology and Environmental Safety, 270, 115925. https://doi.org/10.1016/j.ecoenv.2023.115925

9. Helte, E., Söderlund, F., Säve-Söderbergh, M., Larsson, S. C., & Åkesson, A. (2025). Exposure to drinking water trihalomethanes and risk of cancer: A systematic review of the epidemiologic evidence and dose–response meta-analysis. Environmental Health Perspectives, 133(1), 016001. https://doi.org/10.1289/EHP14505

10. Kumari, M., & Gupta, S. K. (2022). Occurrence and exposure to trihalomethanes in drinking water: a systematic review and meta-analysis. Exposure and Health, 14(4), 915-939. https://doi.org/10.1007/s12403-022-00467-3

11. Seyyedsalehi, M. S., Bonetti, M., Shah, D., DeStefano, V., & Boffetta, P. (2025). Occupational benzene exposure and risk of kidney and bladder cancers: A systematic review and meta-analysis. European Journal of Cancer Prevention, 34(3), 205–213. https://doi.org/10.1097/CEJ.0000000000000911

12. Xie, B., Chen, J., Kai, J., & Li, J. (2025). Association between drinking water disinfection by-products exposure and human bladder cancer: A time-updated meta-analysis of trihalomethanes. Journal of Hazardous Materials, 490, 137833. https://doi.org/10.1016/j.jhazmat.2025.137833

13. Deiana, G., Filippini, T., Dettori, M., Vinceti, M., & Azara, A. (2025). Exposure to disinfection by-products and risk of birth defects: A systematic review and dose-response meta-analysis. Science of the Total Environment, 985, 179693. https://doi.org/10.1016/j.scitotenv.2025.179693

14. United States Environmental Protection Agency (EPA). (2021). National Primary Drinking Water Regulations: Announcement of the Results of EPA's Review of Existing Drinking Water Standards and Request for Public Comment. Fed Regist, 86(216), 62892–62919. Website. [Cited 10 Jan 2026]. Available from URL: https://www.federalregister.gov/d/2021-24795

15. European Union. (2020). European Commission. Directive (EU) 2020/2184 of the European Parliament and of the Council of 16 December 2020 on the quality of water intended for human consumption (recast). Website. [Cited 10 Jan 2026]. https://eur-lex.europa.eu/eli/dir/2020/2184/oj/eng

16. Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. The BMJ, 372, n71. https://doi.org/10.1136/bmj.n71

17. Zyoud, S., & Zyoud, S. H. (2025). Global research trends on the links between disinfection by-products and cancer: Mapping knowledge landscapes and visualization analysis. Journal of Water and Health, 23(9), 1055–1077. https://doi.org/10.2166/wh.2025.058

18. Grellier, J., Rushton, L., Briggs, D. J., & Nieuwenhuijsen, M. J. (2015). Assessing the human health impacts of exposure to disinfection by-products: A critical review of concepts and methods. Environment International, 78, 61–81. https://doi.org/10.1016/j.envint.2015.02.003

19. Levin, R., Villanueva, C. M., Beene, D., Cradock, A. L., Donat-Vargas, C., Lewis, J., Martinez-Morata, I., Minovi, D., Nigra, A. E., Olson, E. D., Schaider, L. A., Ward, M. H., & Deziel, N. C. (2024). US drinking water quality: Exposure risk profiles for seven legacy and emerging contaminants. Journal of Exposure Science & Environmental Epidemiology, 34(1), 3–22. https://doi.org/10.1038/s41370-023-00597-z

20. Özdemir, K., & Özdoğan, N. (2025). Analysis of Trihalomethanes in Drinking Water Distribution Lines and Assessment of Their Carcinogenic Risk Potentials. Sustainability, 17(17), 7618. https://doi.org/10.3390/su17177618

21. Zimoch, I. (2015). Changes of trihalomethanes (THMs) concentration in water distribution system. Desalination and Water Treatment. https://doi.org/10.1080/19443994.2015.1030115

22. Deiana, G., Filippini, T., Dettori, M., Vinceti, M., & Azara, A. (2025). Exposure to disinfection by-products and risk of birth defects: A systematic review and dose–response meta-analysis. Science of the Total Environment, 985, 179693. https://doi.org/10.1016/j.scitotenv.2025.179693

23. Lopes, R. H., Silva, C., Silva, Í. S., Salvador, P., Heller, L., & Uchôa, S. (2022). Worldwide surveillance actions and initiatives of drinking water quality: A scoping review. International Journal of Environmental Research and Public Health, 20(1), 559. https://doi.org/10.3390/ijerph20010559

24. Li, X. F., & Mitch, W. A. (2018). Drinking water disinfection byproducts (DBPs) and human health effects: Multidisciplinary challenges and opportunities. Environmental Science & Technology, 52(4), 1681–1689. https://doi.org/10.1021/acs.est.7b05440

25. National Toxicology Program. (2018). Report on carcinogens monograph on haloacetic acids found as water disinfection by-products. National Toxicology Program. https://doi.org/10.22427/roc-mgraph-12

26. Cotruvo, J. A., & Amato, H. (2019). Trihalomethanes: concentrations, cancer risks, and regulations. Journal-American Water Works Association, 111(1), 12-20. https://doi.org/10.1002/awwa.1210

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Түйіндеме

Тұрғындарды ауыз сумен қамтамасыз ету қауіпсіздігін қамтамасыз ету бүкіл әлемдегі қазіргі заманғы қоғамдық денсаулық сақтаудың маңызды бағыты болып табылады. Соңғы жылдары судағы химиялық қосылыстардың әсер ету қаупі артып келеді, бұл ұзақ мерзімді перспективада адам денсаулығына теріс әсер етуі мүмкін.

Шолудың мақсаты: ауыз судағы тригалометандармен байланысты канцерогендік қаупін бағалаудағы халықаралық тәжірибені салыстырмалы талдау жүргізу.

Әдістері. Шолу PRISMA ұсыныстары негізінде дайындалды. Біз 2015 жылдан 2025 жылға дейін жарияланған ғылыми мақалаларды табу үшін Scopus, PubMed және Web of Science сияқты бірқатар дерекқорларды іздедік: тригалометандар, ауыз су, дезинфекцияның жанама өнімдері, қоршаған ортаға әсері, судың ластануы, өсінділер және дозаға тәуелділік. Іріктеу процесі сәйкестендіруді, скринингті, сәйкестікті бағалауды және қосу кезеңдерін қамтыды. Жалпы, телнұсқалар жойылғаннан кейін 412 жазба тексерілді, оның 298-і алынып тасталды және талдау үшін 26 мақала таңдалды. Таңдалған басылымдар мазмұнды мұқият талдауға, әсерді бағалау әдістемелеріндегі, нормативтік-құқықтық базадағы және мониторинг тәжірибесіндегі аймақтық айырмашылықтарға ерекше назар аудара отырып, тақырыптық және салыстырмалы талдауға ұшырады, онда бірнеше тақырыптық топтар бөлінді: әсерді бағалау әдістері, доза–әсерге тәуелділік, нормативтік-құқықтық базаны салыстырмалы талдау.

Нәтижесі. Талдау дезинфекциялау өнімдерінің әсеріне байланысты тәуекелдерді бағалауға әсер етуі мүмкін зерттеулердегі бірнеше олқылықтарды анықтады. Канцерогендік секілді ұзақ мерзімді тәуекелдерді жақсырақ сипаттау үшін ұзақ бақылау кезеңдері бар бойлық эпидемиологиялық зерттеулер жүргізу қажеттілігі әлі де бар. Орталық Азия мен Шығыс Еуропаның кейбір елдерінен алынған эпидемиологиялық деректер шектеулі болып қала береді. Бұл өңірлік зерттеу бастамалары мен мониторинг жүйелерін жетілдіру қажеттігін көрсетеді. Нормативтік стандарттардағы, мониторинг жүйелеріндегі және әсерді бағалау әдістемелеріндегі айырмашылықтар тәуекелдерді басқару стратегияларының әртүрлі тәсілдеріне әкеледі.

Қорытынды. Тәуекелдерді тиімді төмендетуге суды тазарту технологияларын жетілдіру, мониторингтің кешенді бағдарламаларын енгізу және қоршаған орта мен адам денсаулығы туралы деректерді біріктіру арқылы қол жеткізіледі. Қазақстанды қоса алғанда, Орталық Азия елдері үшін стандартталған мониторинг жүйелерін әзірлеу және қоршаған ортаның жай-күйін қадағалау жүйелерін нығайту ауыз судың қауіпсіздігін арттыру және ықтимал канцерогендік тәуекелдерді төмендету жолындағы маңызды қадамдар болып табылады.

Түйін сөздер: тригалометандар, ауыз су, қоршаған ортаға әсер ету, суды ластаушы заттар, қатерлі ісіктер, канцерогендік тәуекел.

Оценка влияния тригалометанов, содержащихся в питьевой воде, на риск развития рака: Литературный обзор

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Резюме

Обеспечение безопасности питьевого водоснабжения населения является важным направлением современного общественного здравоохранения во всем мире. В последние годы возрастает риск потенциальной опасности воздействия химических соединений в воде, что в последствии может иметь негативное влияние на здоровье человека в долгосрочной перспективе.

Цель обзора: провести сравнительный анализ международного опыта оценки канцерогенных рисков, связанных с тригалометанами в питьевой воде.

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Методы. Обзор был подготовлен на основе рекомендаций PRISMA. Мы провели поиск в ряде баз данных, включая Scopus, PubMed и Web of Science, чтобы найти научные статьи, опубликованные с 2015 по 2025 год, по ключевым словам. Процесс отбора включал в себя идентификацию, скрининг, оценку соответствия требованиям и этапы включения. В общей сложности, после удаления дубликатов было проверено 412 записей, из которых 298 были исключены, а для анализа было отобрано 26 статей. Отобранные публикации были подвергнуты тщательному анализу содержания, тематическому и сравнительному анализу с уделением особого внимания региональным различиям в методологиях оценки воздействия, нормативно-правовой базе и практике мониторинга, где были выделены несколько тематических групп: методы оценки воздействия, зависимость доза-эффект, сравнительный анализ нормативно-правовой базы.

Результаты. Анализ выявил несколько пробелов в исследованиях, которые могли повлиять на оценку рисков, связанных с воздействием продуктов дезинфекции. По-прежнему существует необходимость в проведении лонгитюдных эпидемиологических исследований с длительными периодами наблюдения, чтобы лучше охарактеризовать долгосрочные риски, такие как канцерогенные. Эпидемиологические данные из некоторых стран Центральной Азии и Восточной Европы остаются ограниченными, что подчеркивает необходимость региональных исследовательских инициатив и совершенствования систем мониторинга. Различия в нормативных стандартах, системах мониторинга и методологиях оценки воздействия приводят к различным подходам к стратегиям управления рисками.

Выводы. Эффективное снижение рисков достигается за счет совершенствования технологий очистки воды, внедрения комплексных программ мониторинга и интеграции данных об окружающей среде и здоровье человека. Для стран Центральной Азии, включая Казахстан, разработка стандартизированных систем мониторинга и укрепление систем надзора за состоянием окружающей среды являются важными шагами на пути повышения безопасности питьевой воды и снижения потенциальных канцерогенных рисков.

Ключевые слова: тригалометаны, питьевая вода, воздействие на окружающую среду, загрязнители воды, злокачественные новообразования, канцерогенный риск.

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