Review

Worldwide Surveillance Actions and Initiatives of Drinking Water Quality: A Scoping Review

Rayssa Horacio Lopes¹*, Cícera Renata Diniz Vieira Silva², Ísis de Siqueira Silva¹, Pétala Tuani Cândido de Oliveira Salvador³, Léo Heller⁴ and Severina Alice da Costa Uchôa⁵

1 Graduation Program in Collective Health, Federal University of Rio Grande do Norte, Natal, ZIP code: 59064-630, Brazil. rayssa.lopes@ufrn.br (R.H.L.); isis.siqueira.176@ufrn.edu.br (Í.S.S.).
2 Technical School of Health of Cajazeiras, Federal University of Campina Grande, Cajazeiras, ZIP code: 58900-000, Brazil. cicera.renata@professor.ufcg.edu.br
3 School of Health, Federal University of Rio Grande do Norte, Natal, ZIP code: 59078-970, Brazil. petala.salvador@ufrn.br
4 René Rachou Institute, Oswaldo Cruz Foundation, Belo Horizonte, ZIP code: 30190-009, Brazil. leo.heller@fiocruz.br
5 Public Health Department, Federal University of Rio Grande do Norte, Natal, ZIP code: 59078-900, Brazil. alice.costa@ufrn.br

Correspondence: rayssahlt@hotmail.com; Tel.: +55-8433422290

Abstract: This study identified and mapped worldwide surveillance actions and initiatives of drinking water quality implemented by government agencies or public health services. The scoping review was conducted between July 2021 and August 2022 based on the Joanna Briggs Institute. The search was performed in relevant databases and grey literature; 49 studies were obtained. Quantitative variables were presented as absolute and relative frequencies, while qualitative variables were analyzed using the IRaMuTeQ software. The actions developed worldwide and their impacts and results provided four thematic classes: (1) assessment of coverage, accessibility, quantity, and drinking water quality in routine and emergency situations; (2) analysis of physical-chemical and microbiological parameters in public supply networks or alternative water supply solutions; (3) identification of household water contamination, communication, and education with the community; (4) and investigation of water-borne disease outbreaks. Preliminary results were shared with stakeholders to favor early knowledge dissemination.

Keywords: Drinking water; potable water; public health surveillance; quality control; government

1. Introduction

Water is a central element for sustainable development and essential to human survival, socioeconomic development, energy, and food production. Thus, a balance between human demands and commercial needs competing with the use of increasingly scarce water resources is needed, given the worldwide population growth[1-3].

Drinking water and sanitation are fundamental rights recognized by the United Nations (UN) since 2010[2,4,5]. They also represent one of the main milestones for ensuring sufficient, safe, acceptable, and affordable water access, reducing diseases, and improving worldwide health, education, and economic productivity. Recently, access to water was included in the sustainable development goals (SDG), which prioritized access to water for all by 2030 to reduce social and health inequalities[6]. However, this goal may not be achieved, considering the challenge of extending services to rural and poorer areas with vulnerable populations[7]. The increased water scarcity, including limited access to safe drinking water and sanitation, the increased pressure on water resources and ecosystems, and the exacerbated risk of droughts and floods, led the UN to create the Water Action Decade (2018 – 2028) to focus efforts to reach the SDG 6[1].

The direct use and contact with poor quality water may harm to the health and well-being of people, increasing the need for the monitoring of water quality. Moreover, low-

income countries often do not present routine programs, leading to lack or scarcity of data on water quality and exposing the health of millions of people[3,8]. In this sense, the World Health Organization (WHO) has concentrated efforts on water safety since 1958 by publishing international standards and guidelines on drinking water quality [3].

However, these legal standards alone do not ensure compliance and implementation, especially in regions with limited government and resources[9]. For example, a study illustrated the contamination of water sources by coliforms, bacterial or chemical contaminants, and high concentrations of arsenic, manganese, and iron[10]. Another study, assessed drinking water quality in low- and middle-income countries and demonstrated that most of the population studied was exposed to fecal contamination; significant differences in water quality were also found between people from low- and middle-income countries[11]. These findings highlight the differences in quality between points of collection and use and the efforts needed to strengthen the surveillance of water quality by regulatory agencies [11].

The guarantee of safe and accessible drinking water requires improved risk-based monitoring information (e.g., climate, salinity, and heavy rainfall), clarity and responsibilities of institutional roles to inform data about the actions based on water safety evidence, and expansion of investments in water security planning, including in rural areas[12], which is complex given the overlap of ministries and organizations for water management[8].

In this context, public health must assume responsibility since health surveillance is important for providing information to develop actions and interventions, reduce risks, and promote health, especially in the context of globalization that causes pollution, affects the environment, and impacts the lives of people[13]. Therefore, the surveillance of drinking water quality developed by public health authorities is important for public health protection because it identifies and assesses potential risks for collective health related to drinking water and contributes to improving water quality, quantity, accessibility, coverage, and source continuity. This surveillance must also generate periodic reports about water quality and public health concerns and priorities, which may require exchanging information from various agencies[3].

Considering the need to establish surveillance actions of drinking water quality developed by public health agencies or authorities, it is essential to know and compare the actions developed worldwide to identify their possible use by professionals and managers and define gaps for future research. Therefore, this study aimed to identify and map surveillance actions and initiatives of drinking water quality implemented worldwide by governmental agencies or public health services.

2. Materials and Methods

2.1. Study type

This scoping review[14,15] was conducted between July 2021 and August 2022 based on the Joanna Briggs Institute[14], Arksey and O'Malley[16], Levac, Colquhoun, and O'Brien[17], and and Peters and colleagues[14]. The following stages were used for elaborating the review: definition and alignment of objectives and research questions; development and alignment of inclusion criteria; description of evidence selection; evidence search; evidence selection; evidence extraction; evidence analysis; presentation of results; and summary of the evidence, conclusions, and implication of findings[14,17,18].

The detailed methodology was published in a protocol[19]. The main alteration of this review was related to the mapping of studies: we used the world map from an electronic spreadsheet (Google Sheets, Google LLC, Mountain View, CA) to better address the mapping instead of the GeoDa software.

2.2. Definition of research questions and inclusion criteria

The following research questions were defined considering the mnemonic Population, Concept, and Context after consensus among authors: (1) what are the worldwide

actions and initiatives of surveillance of drinking water quality implemented by government agencies or public health services?; (2) what are the impacts and results of the implemented surveillance actions of drinking water quality?; and (3) what are the challenges and limitations for developing surveillance actions of drinking water quality?

We included publications (i.e., research articles [experience reports and quantitative, qualitative, or mixed studies], theses, dissertations, or official documents) regarding surveillance actions of drinking water quality implemented by public health agencies or authorities worldwide. No language, period, or country filters were considered. Duplicated studies, literature reviews, theoretical essays, editorials, expert opinions, conference and congress annals, or publications considering water for other uses than human consumption were excluded.

2.3. Description, search, selection, and extraction of evidence

The search was conducted from September 4, 2021, to November 29, 2021, in three stages: (1) consultation of descriptors, keywords, and synonyms to elaborate the search, which was revised and improved by a librarian; (2) search in peer-reviewed (Medline/PubMed, Scopus, Web of Science, Embase, LILACS via Biblioteca Virtual em Saúde [BVS], and Engineering Village databases) and grey literature (Google Academic, Open Access Theses and Dissertations [OATD], ProQuest Dissertations & Theses Global [PQDT], Biblioteca Digital de Teses e Dissertações [BDTD], and Catálogo de Teses & Dissertações – CAPES); and (3) manual consultation in the reference list of selected publications. Complete search strategies used in the identified data sources and results are shower in table S1.

Study selection followed the steps of identification, screening, eligibility, and inclusion[20]. The Rayyan[21] software free version (Qatar foundation, Doha, Qatar) was used to organize the results, remove duplicates, and analyze titles and abstracts. The remaining stages of the review were blindly conducted by two authors (RHL and CRDVS).   These authors also performed a pilot test in each stage of the study to calibrate and adapt the protocol. All conflicts were resolved by consensus. Reasons for exclusion of the publications analyzed in full text are presented in Table S2.

Two independent reviewers (RHL and CRDVS) extracted the evidence. The form was based on the JBI Manual for Evidence Synthesis[14] and included the following variables: type of material, year of publication, publication context, academic degree of the main author, aims, type of research, surveillance actions and the responsible agencies, impacts or results, and challenges or limitations. The peer extraction and ethical attention of researchers ensured the reliability and consistency of the extracted data.

2.4. Analysis of evidence

A descriptive synthesis was performed, and quantitative variables (i.e., type of material, year, context, academic degree, research, and responsible for the action) were presented as absolute and relative frequencies. Regarding qualitative variables (i.e., surveillance action, impacts or results, and challenges and limitations of the actions), textual fragments extracted from results and conclusions of the included publications were analyzed using the Interface de R pour les Analyses Multidimensionnelles de Textes et de Questionnaires (IRaMuTeQ) software. This software analyzes the structure and text organization and informs connections between the most frequently reported lexical worlds [22,23]. All textual fragments were translated into Portuguese (i.e., native language of the researchers) and revised to produce the corpus and subsequent analyses.

The IRaMuTeQ analyzed variables related to surveillance of drinking water quality developed worldwide and their impacts and results. Next, emerging classes were identified in the analyzed variables using the descendent hierarchical classification, followed by a dendrogram elaborated according to values obtained by the chi-square (χ^2). High χ^2 values represented strong associations between the word and the class; words with $\chi^2 < 3.84$

were not considered (p < 0.05). Challenges and limitations of surveillance actions were submitted to similarity analysis[22,23].

2.5. Consultation with the stakeholders

Preliminary results were analyzed by seven specialists with technical or research expertise in surveillance of drinking water quality using the Google Forms® platform. The following questions were considered according to Levac, Colquhoun, and O'Brien[17]: ways of disseminating knowledge, applicability of services in surveillance of water quality, and research gaps or suggestions for future studies. This stage was approved by the research ethics committee mentioned in the study protocol, and all stakeholders signed an informed consent form[19].

3. Results and discussion

The identification process resulted in 26,235 studies, of which 4,388 were from searches in databases (Scopus: 2,030; Medline/PubMed: 720; Engineering Village: 676; Web of Science: 546; EMBASE: 289; LILACS via BVS - Portuguese: 94; and LILACS via BVS - English: 33) and 21,847 from the grey literature (Google Scholar: 21,800; Catálogo de Teses e Dissertações - CAPES: 36; PQDT: 7; BDTD: 2; and OATD: 2). A total of 47 publications were selected after the screening and eligibility stages, and 2 references were added after consultation on reference lists, resulting in a final sample of 49 studies (Table S.3). The flowchart of study selection is shown in Figure 1.
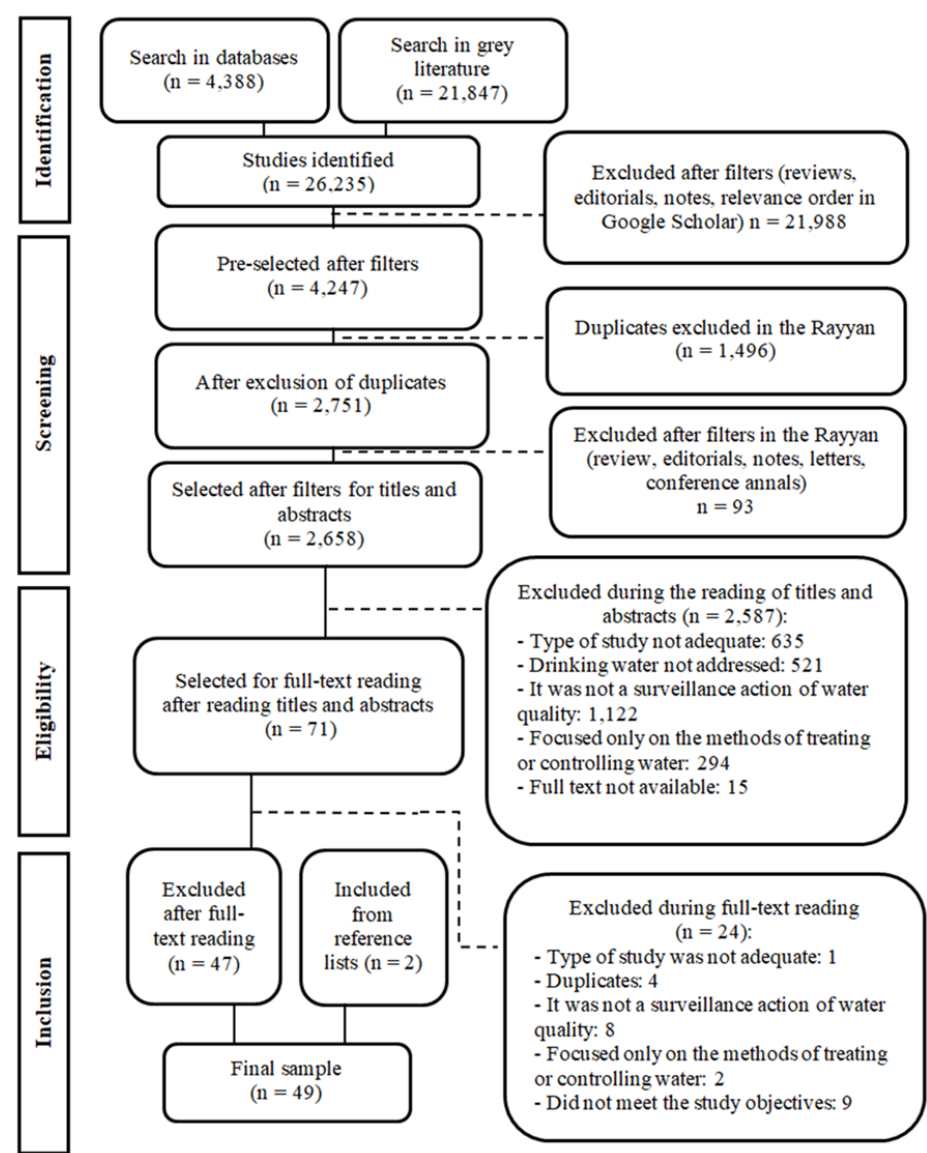
Figure 1. – Flowchart of study selection adapted from the Preferred Reporting Items for Systematic Review and Meta-Analyzes[20].

3.1. Characterization of included studies

The most included studies were peer-reviewed articles (32; 65.3%), followed by reports of surveillance actions (13; 26.5%) and dissertations of Master's in Science (4; 8.2%). The number of publications increased between 1993 and 2020, mainly in 2017 (6; 12.2%). According to studies, surveillance actions were developed in several countries, mostly in the USA (17; 34.7%) and Brazil (14; 28.6%) (Figure 2).

Figure 2. – Distribution of surveillance actions developed worldwide.

The USA has assumed the leading role in developing concepts and models of public health surveillance. The Center for Diseases Control, for example, was a catalyst for this process and is actually responsible for public health surveillance and outbreaks of water-borne diseases (WBDOS) in the country; the latter is currently a publication of the National Notifiable Diseases Surveillance System[24,25]. In addition, the United States Enviromental Protection Agency approved the Safe Drinking Water Act in 1974 as a form of public health protection [26].

Brazil stands out in the surveillance of drinking water quality for human consumption by assigning the Unified Health System (SUS) to perform water inspections and elaborate policies and actions in basic sanitation[27]. Furthermore, specific and periodically updated legislation supports the control, surveillance, and drinking water standards for human consumption[28]. The SUS also has the "Vigiagua" and "Sisagua" programs, which provide public domain data used in research, action management, and monitoring of water quality consumed by the population[29]. Brazil is one of the few countries that routinely publish data favoring an in-depth analysis of inequalities in drinking water quality[7].

The career of the first author was identified in 40 studies (81.6%); most were medical doctors (6; 12.2%), nurses (5; 10.2%), biological and chemical scientists (4; 8.2%), civil engineers, and veterinarians (3; 6.1%). Other careers less identified were from health, engineering, environmental, and social areas. The various careers reflect the need for action in the area and the articulation of different knowledge and practices[3].

The study design was described in some publications (24; 48.90%): descriptive (8; 16.32%)[30-37], cross-sectional or ecological (4; 8.16%)[38-41], documentary (3; 6.12%)[42-44], retrospective cohort[45,46], epidemiological[47,48], case study[49], action research[50], experience report[51], and quantitative-qualitative evaluative and mixed-methods research[52]. Other publications were reports regarding surveillance actions (14; 28.57%)[53-66]. These reports describing water quality must be produced periodically by public health authorities, integrated into management and policy actions, and combined with better dissemination and communication among stakeholders[3,8].

The responsible for health surveillance actions were professionals linked to public health departments (40; 81.63%) from municipal, state, or federal spheres[31-40,42,43,46-51,53-63,65,67-76], agencies responsible for water protection[45,77], department of environment and conservation[41], department of public health engineering[78], national water laboratory[30], or in-field sanitary inspectors of the water test laboratory[52]. Sometimes, the surveillance involved other sectors besides health (e.g., environmental, civil

protection, and responsible for the supply)[45-47,49,55,65] or was conducted by a national network for monitoring environmental public health[64,66].

The superposition of several ministries and organizations responsible for water management hinders the management of this area, which requires an institutional approach to seek its quality since it is essential to human development[8]. However, the reality observed in the studies showed that most Ministries of Health (or related to public health) were the main responsible for the surveillance of drinking water; in other countries, an agency related to environmental protection was responsible for this initiative [3].

3.2. Surveillance actions of drinking water quality and their impacts and results: Descending Hierarchical Classification

The corpus was composed of 49 texts divided into 207 segments of text (ST), of which 176 ST were used (85.02%). A total of 7,563 occurrences were found (words, shapes, or vocables): 1,640 were distinct words, and 911 occurred only once. The analyzed content was categorized into four classes and named according to Figure 3.
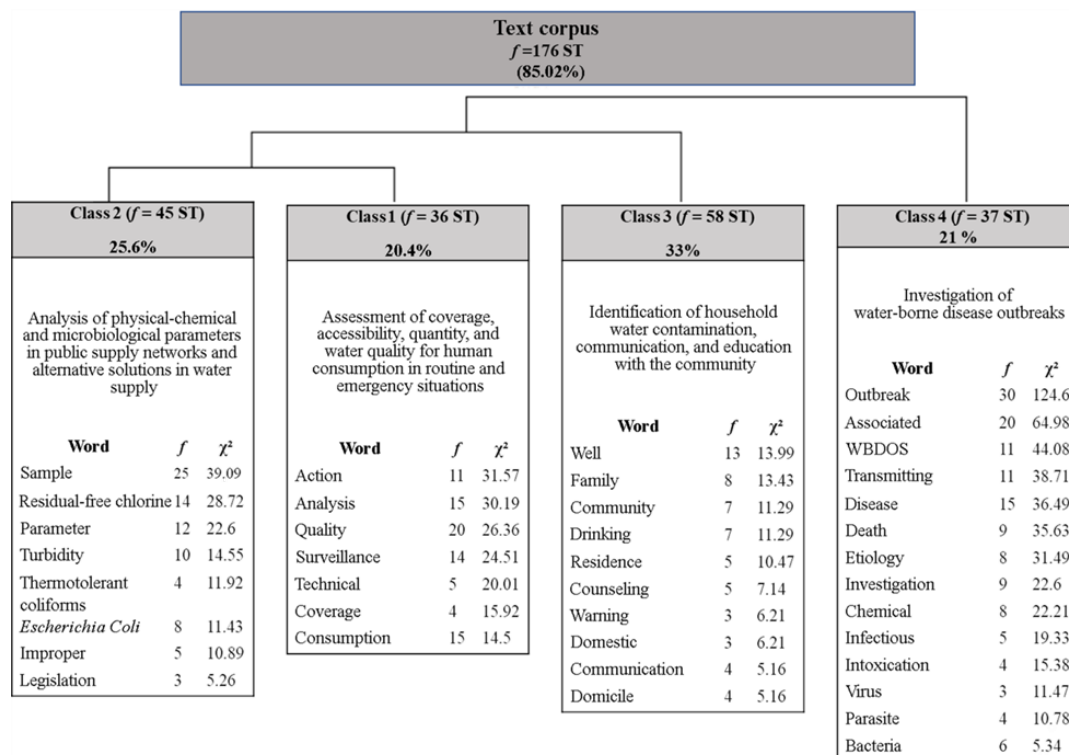
Figure 3. – Dendrogram of the Descending Hierarchical Classification describing classes, frequency, and the chi-square (χ^2).

Legend: ST – segments of text; f – frequency; χ^2 - chi-square; WBDOS – water-borne diseases.

3.2.1. Class 1 – Assessment of coverage, accessibility, quantity, and drinking water quality in routine and emergency situations

This class represented the actions developed by authorities responsible for the surveillance of drinking water quality in routine and emergency situations. The actions sought to ensure adequate drinking water quality, quantity, and access (supply systems) for the population. In most cases, these actions required the articulation between services responsible for water supply and the other services responsible to public health surveillance.

A total of 20.4% of the analyzed material was represented in this class (f = 36 ST), composed by words and radicals (e.g., analysis, quality, surveillance, technical, coverage, and consumption) in the interval between $\chi^2 = 3.91$ (health) and $\chi^2 = 31.57$ (action).

Surveillance actions assessing the coverage, quantity, and accessibility of drinking water for the population were poorly highlighted in studies conducted in Costa Rica[30,44], Brazil[35], and India[52]. Some studies revealed locations in which almost the entire population was supplied[30,44]. Other studies demonstrated that, although all small residences had access to water, the offer was limited to two hours per day, motivating water storage and pumps to obtain more water during the period of supply[52], and verifying the consumption per capita was impossible due to limitations in the information system[35].

Nevertheless, the operational and maintenance costs for infrastructure expansion of drinking water and sanitation services, hindered many countries from adequately providing these services to the population. About 2 billion people do not have access to drinking water, reflecting the worldwide crisis experienced nowadays, because of two major structural flaws: inequality and poverty. The former results from lack of support from socioeconomic systems, while the latter is related to the unsustainable relation with aquatic ecosystems, transforming water into a dangerous vector of disease and death[79].

Most studies included in this class highlighted actions related to assessing water quality offered in routine situations according to contaminant levels[30,44,70,72,75,77]. They also mentioned a possible seasonal pattern in water contamination during winter and summer[70] or in March and April[35].

Changes in rainfall impact water quality (i.e., increased rainfalls may overload domestic and industrial sewage collection systems), leading to the disposal of raw sewage into water courses and increasing the risk of contamination by pathogens. Alternatively, droughts may increase the salinity of the soil and freshwater sources, decreasing the dilution of pollutants[8] and, consequently, groundwater formation and water supply for part of the population[80]. Thus, climate variables (e.g., precipitation, humidity, evaporation, and temperature) may contribute to outbreaks of diarrheal diseases[81], which may mostly affect children below five during very dry and hot seasons or high humidity[82].

Another important result was the difference in data and information related to water quality between agencies responsible for water supply and health surveillance[38,42]. This situation is problematic since data are crucial to policy making, development of new programs and interventions, and improve public communication, research assessment, and investment allocation[83]. Also, divergences may compromise the correct alignment of adequate interventions.

Nevertheless, the availability of global indicators related to water supply, sanitation, and hygiene constantly improved in the first five years of SDG. Moreover, national estimations related to safe management of drinking water increased from 96 to 138 countries, including in rural (from 20 to 65 countries) and urban regions (from 42 to 87 countries)[7].

Concerns about water contaminants must also be highlighted. Currently, thermotolerant coliforms are the most reported water contaminants; however, contamination by hydrocarbons and pesticides from local industrial and agricole models is also worrisome[30]. A study in Denmark found that only 0.5% of samples from public drinking water presented pesticides, and 16% of these exceeded the recommended levels by the national standard[84]. This reality is very different from low-income countries, where agriculture and raw sewage represent increased threats to water quality[8]. Thus, periodic water quality monitoring is needed, especially in locations where chemical contaminants (e.g., pesticides) are found [85].

A review conducted in Brazil revealed that the main chemical contaminants found in drinking water were from soil composition, mining, sewage, and agriculture; pesticides were the most relevant[21]. This finding is a problem for public health since 55 of the identified contaminants were not listed in the current Brazilian water quality parameters for routine sampling[85].

Surveillance actions of drinking water quality in emergency situations were related to natural or anthropogenic disasters, such as tsunamis[49], dam failure accidents[51], and environmental disasters in the paper industry[31]. The actions involved the identification of priorities related to drinking water quality[49], including periodic monitoring and collective and individual supply solutions to gather water from underground sources in the affected municipalities[51]; detection of vulnerable points in the network[31] to improve the microbiological and chemical safety of water; and analysis of household wells to classify the risk in water consumption[9]. The need to create intersectoral technical working groups[31] or operating committees for integrating essential areas to attend to emergencies[51] was also highlighted, besides the installation of chlorinated water tanks, distribution of domestic water treatment reagents to residences in the affected areas[65], and improvements in water management related to source protection, disinfection practices, and attention to contamination[49].

The increased exposure to risks caused by consumption patterns, working conditions, and exposure to chemicals associated with the appropriation of nature by humankind is leading to environmental degradation, which may increase the occurrence of disasters and emergencies in public health. This implicates the need for immediate action not only in health care and surveillance but also in other areas of action according to the characteristics of the event[86].

In this context, a study revealed that the effects of natural disasters on health represented an important challenge for public health due to its several derived factors (e.g., vulnerability of the population and the economic development model adopted, which often affects the climate) and required a coordinated risk management action among all levels across health sectors [87].

3.2.2. Class 2 – Analysis of physical-chemical and microbiological parameters in public supply networks and alternative water supply solutions

Class 2 was at the same level of the dendrogram as class 1 (Figure 3). Class 2 was based on the assessment of parameters related to the supply of quality water and linked to specific legislation in countries that standardized and limited the contaminant levels for coliforms, physical-chemical parameters (e.g., turbidity, pH, color, and temperature), and other microbiological indicators. The essential role of routine and systematized information on these parameters was highlighted to support health surveillance actions.

Class 2 comprised 45 ST (25.60%), with words between $\chi^2 = 4.48$ (total coliforms) and $\chi^2 = 39.09$ (sample). The following words were presented: residual free chlorine ($\chi^2 = 28.72$), parameter ($\chi^2 = 22.60$), turbidity ($\chi^2 = 14.55$), thermotolerant coliforms ($\chi^2 = 11.92$), Escherichia Coli ($\chi^2 = 11.43$), improper ($\chi^2 = 10.89$), legislation ($\chi^2 = 5.26$).

Residual-free chlorine is a widely searched indicator among the parameters used to assess water quality[33,35,36,38,40,42,52,65]. The inadequate chlorination was identified as a vulnerable factor in alternative solutions for water supply, exposing the population to the risk of microbiological contamination[33]. In addition, turbidity was analyzed as a relevant indicator[35,36,38,40-42,50,52,54] and frequently associated with acute diarrhea if the maximum limit is exceeded[38]. Bacterial contamination by coliform[33-35,38,40,42,46,52,69,73] and Escherichia Coli[34,36,40,46,52,65,76] were also correlated with the emergence of acute diarrhea[76]. The assessment of fluoride levels was indicated as a potential parameter for preventing cavities in the population [32,36,37,42,48].

A study in Zimbabwe investigated the quality of alternative water sources and their distribution system. The authors revealed that, although samples attended the WHO recommendations for physical-chemical parameters, the microbiological requisites were not met due to coliform contamination regardless of water source and location. Moreover, Escherichia Coli and Salmonella spp. were found in some samples. Multidrug resistance (amoxicillin, ampicillin, and cephalothin) was also identified, indicating that water was unsafe for human consumption without further treatment[88]. Other problems identified were the lack of information or irregular registration of some parameters[36,76], lack of

inspection of water quality and registration of water sources[35], and reduced compliance with surveillance actions in rural areas[40].

A study identified the relevance of the Jupiter database, which is an open-access database that centralizes the register of chemical analyses and allows the assessment of drinking water using a spatial-temporal categorization despite the high heterogeneity of sampling frequencies and type of pesticide analyzed may be a limiting factor[84].

3.2.3. Class 3 – Identification of household water contamination, communication, and education with the community

This class was linked to Classes 1 and 2 on the external level within the dendrogram and represented the identification of water contaminants at the household level and the dissemination and education needed with the community, especially in situations of risk.

The class 3 comprised 33% of ST analyzed (f = 58 ST) and considered words in the interval between $\chi^2 = 16.96$ (use) and $\chi^2 = 4.88$ (affected). The following words were presented: well ($\chi^2 = 13.99$), family ($\chi^2 = 13.43$), community ($\chi^2 = 11.29$), drinking ($\chi^2 = 11.29$), residence ($\chi^2 = 10.47$), counseling ($\chi^2 = 7.14$), warning ($\chi^2 = 6.21$), domestic ($\chi^2 = 6.21$), communication ($\chi^2 = 5.16$), domicile ($\chi^2 = 5.16$.

The surveillance actions of water quality highlighted in this class addressed the identification of chemical contaminants in households (i.e., lead[71,73], arsenic[67,72,73], iron[71,73,78], nitrate[69,73,78], fluoride[47,78], aluminum, manganese, strontium, and nitrogen[73]), revealed locations that did not fully comply with regulations of chemical contamination[49], and identified volatile organic compounds within the allowed level[69]. Identifying these contaminants has been part of testing programs at residences of people from risk groups (e.g., women with children[71], low-income families with pregnant women, and young children[73]) and assessments of supply sources and sources needing treatment after a disaster[51].

Chemical contamination represents a major challenge for public health because of its effects after long-term exposures, interfering with the comprehension of risky situations and elaboration of preventive measures. Furthermore, emerging pollutants (e.g., medicines, endocrine deregulators, pesticides, organic products, metals, and illicit drugs) are not routinely monitored because they are not listed as common chemical contaminants[85]. In this sense, efforts are needed to regulate the monitoring of these substances, considering the economic activities or local characteristics of sanitary sewage [85]. For instance, the extensive use of nitrogen-containing fertilizers raises nitrate levels in groundwater and increases the risk for people consuming this water; thus, the protection of groundwater source areas is needed to meet the supply needs of the economic development[89].

The following communication and education with the community were developed in situations of microcystin contamination: alerts to the population (e.g., warnings to boil water)[63], risk classification of wells (including with Salmonella sp.)[49], guidance for families affected by disasters[51], counseling in residential and commercial systems[39], and conscientization campaigns for the rural population to improve water sources and comprehend the role of drinking water in health[78].

In this context, risk communication by professionals working with drinking water may occur on many occasions, such as unexpected events or disasters (e.g., chemical spills, outbreaks, hurricanes, and power outages) or during a routine inspection[90]. Water systems or agencies must provide information to the population, encourage action preparation and recommendations, or comply with precepts of legal public notification when its quality is compromised. These warnings must include information about water boiling and avoid its use for drinking or other finalities[91].

The risks from environmental issues may be frequently seen as more alarming and with less understanding than other health risks because they are often invisible and disproportionately affect part of the population, requiring communication professionals with the ability to explain situations clearly, succinctly, and empathically[90].

The effectiveness of risk communication relies on health literacy issues, which represent the ability to receive information, comprehend, and act adequately to make decisions[91]. Furthermore, recognizing the characteristics in the target audience (e.g., age, socioeconomic level, educational level, culture, language, environmental preoccupation, and environmental health literacy) is essential for effective and transparent communication with the audience[92].

The recognition of work, continuing education of workers, community participation, social responsibility, social accountability, political support, and personal commitment were also reported as essential elements for successful surveillance actions of water quality[50]. Furthermore, the capacitation of health workers is needed, especially in low-income countries, to improve the use of geographical information system tools during vulnerability mapping and increase the interconnection between human and earth health, socioeconomic transitions, and climate changes. Data from passive surveillance, disease outbreak reporting systems, and environmental and climatic observations may also be used to assess patterns and trends of diseases[93].

Public health surveillance systems must be strengthened by adequately allocating resources and constantly training of the team to use information in the prioritization, planning, action, and assessment of actions[24]. Furthermore, citizen participation in monitoring population health should be highlighted and explored[93].

3.2.4. Class 4 – Investigation of water-borne disease outbreaks

Class 4 comprised the most different topic and represented the investigation of factors associated with WBDOS, including data analysis on drinking water affected by outbreaks that caused illness, hospitalization, and death[53,56-62,68].

This class comprised 21% of the material analyzed (f = 37 ST) and considered words in the interval between χ^2 = 124.60 (outbreak) and χ^2 = 4.24 (positive). It presented representative words, such as associated (χ^2 = 64.98), WBDOS (χ^2 = 44.08), transmitting (χ^2 = 38.71), disease (χ^2 = 36.49), death (χ^2 = 35.63), etiology (χ^2 = 31.49), investigation (χ^2 = 22.60), chemical (χ^2 = 22.21), infectious (χ^2 = 19.33), intoxication (χ^2 = 15.38), virus (χ^2 = 11.47), parasite (χ^2 = 10.78), and bacteria (χ^2 = 5.34).

Several states of the USA and Canada investigated reported or suspected cases of WBDOS, in which etiological agents were unknown[68], unidentified[53,57], or linked to infectious agents (i.e., bacteria, viruses, and parasites)[56 – 62, 68]; some cases were related to multiple etiology[61,62]. Chemical poisoning by sodium hydroxide[56,58,62], copper[56,57,59], nitrate[53,58], nitrite[56], tilbenzene, toluene, xylene[59], and toxins[60] was also reported.

Outbreaks were associated with the community, non-community, or individual water systems[56,57] and unregulated private or non-community wells[58] in the USA and Canada; nearly half of the outbreaks investigated were in semi-public systems[68]. Superficial[57] and groundwater[53,58,61] sources of these systems were also linked to outbreaks .

In the USA, the public health authority uses data from the states to monitor diseases, risk factors, and public health issues of collective interest. They also screen for outbreaks possibly related to contaminated water, such as Escherichia Coli or other non-infectious causes (e.g., lead poisoning)[83], to reveal deficiencies in the water supply system.

Deficiencies possibly associated with the emergence of outbreaks were linked to water source, treatment plant or distribution system[60-62], and use of non-treated groundwater[62]; some were unknown or out of the jurisdiction of the water utility or location of use[60,61]. Gastrointestinal diseases[47,53], acute diarrhea[54], hepatitis A, cryptosporidiosis, and giardiasis[53] were also present, and more serious cases resulted in death (e.g., chemical poisoning by fluoride)[53].

3.3. *Challenges and limitations of surveillance actions of water quality: similarity analysis*

The corpus produced by the variable "challenges and limitations of surveillance actions of water quality" comprised 49 texts divided into 76 ST; 54 ST (71.05%) were used. A total of 2,537 occurrences emerged (words, forms, and vocables): 872 were different words and 596 had a single occurrence. The minimum cut-off point for similarity analysis is twice the ratio between the number of occurrences and the number of forms[22,23]. In this case, the frequency considered for the analysis was 3 x 2.9 = 8.7 of words above this cut-off that presented theoretical coherence with the analyzed results, except for the words "no", "as", and "more".

The material analyzed produced an image comprising five halo communities; three words that stood out: "water", "data", and "surveillance". The former is the central element derived from other communities and words. The central part was composed of the word "water" linked to "potable", "quality", "information", and "lack", which ramifications were composed of the words "treatment", "system", "analysis", and "municipalities" (right ramification); "source", "population", and "difficulty" (central ramification); and "notification", "outbreak", "disease", "location", "health", and "data" (left ramification). A sub-ramification derived from the left ramification was composed of the words "report", "number", and "sample" (Figure 4).
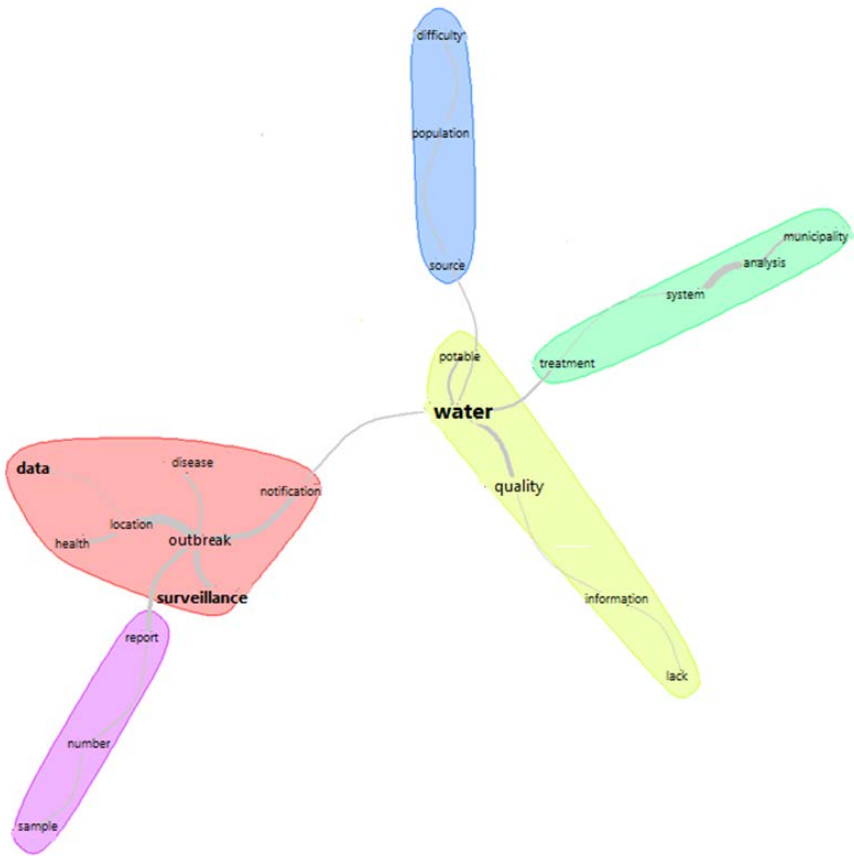
Figure 4. - Similarity analysis of challenges and limitations of surveillance of drinking water quality worldwide. Presentation Fruchterman Reingold, chi-square scores with community and halo.

The main challenges and limitations related to surveillance actions of water quality were the lack of information about drinking water quality due to insufficient samples, lack of data standardization regarding the analysis of systems supply provided by municipalities, and difficulties in identifying sources and water treatment, which hinder the surveillance and report of outbreaks associated with water-borne diseases.

In this sense, public health surveillance actions still lack information systems that aggregate relevant and essential data from different sources. Although the coverage of surveillance systems still limited, fragmented, and unequal and hinders knowledge

exchange and integration, computational technologies may help optimize their quality, capacity, and efficacy [24].

The monitoring and assessment of water quality offer important opportunities for innovation in the 21st century, especially regarding information and communication technology, that may contribute to several strategies (e.g., use of data for modeling, remote sensing, and machine-learning approaches). These technologies and science initiatives may fill data gaps[94,95] and potentially contribute to achieving SDG[8,93].

3.4. Consultation with stakeholders

Seven stakeholders (five technical professionals in the area and two researchers) with practical or research experience in water quality surveillance for human consumption responded to the form requesting an appraisal of the results.

Regarding the disclosure of results, the publication of a scientific article was almost unanimous. One respondent indicated an open material (e.g., booklet or newspaper) for easy access to the population, while another indicated the presentation of results to those responsible for monitoring water quality in municipalities. Stakeholders also discussed the applicability of results, considered support for action. For example, results could help identify the main challenges to action development and potential adaptations, guide activities, and improve and qualify surveillance actions of water quality for human consumption in the countries.

Gaps and suggestions for future studies comprised the need for (1) greater clarity on the concept of monitoring drinking water quality; (2) on-site visits for the appropriation of developed actions; (3) conceptualization of didactic material for the population; (4) assessment of water quality in areas of informal occupation, flooding, or use of pesticides; (5) assessment of water quality indicators and WBDOS, (6) assessment of the impact of actions on the community, (7) incorporation of information on water security plans, and (8) use of information systems by the countries.

3.5. Limitations

Despite the search with a highly sensitive strategy, important documents from countries may not have been retrieved during searches in databases. Although we did not limit the language for inclusion of studies, the search performed with terms only in English and Portuguese may be considered a limitation of the study.

4. Conclusions

This scoping review identified and mapped the main worldwide actions and initiatives to monitor drinking water quality. The results revealed that the USA and Brazil were the countries that most published actions developed by professionals with varied academic backgrounds.

The four thematic classes in this review detailed the actions and their results in the countries. The preliminary results were also shared with stakeholders, favoring the early dissemination of knowledge.

This review identified important issues that need to be analyzed so that surveillance actions of drinking water quality contribute to safe access to water. The qualification of professionals for routine and emergency situations is also needed, including the ability to perform risk communication; the capacity to consider health literacy of populations to achieve better results in actions of health information, communication, and education; the need for surveillance systems of water quality responsive to outbreaks or water-related issues affecting human health; and the reduction of inequalities related to access to quality water between rural and urban areas. These points also represent research gaps that must be addressed by future studies to improve surveillance actions of drinking water quality.

Supplementary Materials: The following supporting information can be downloaded at: www.mdpi.com/xxx/s1, Table S1: Complete search strategies used in the identified data sources and

results.; Table S2: Reasons for exclusion of the publications analyzed in full text.; Table S3: Characterization of sample according to reference, graduation from the 1st author, country and objective of the study.

References

1. United Nations. (2018) WATER ACTION DECADE 2018-2028. Available at: https://wateractiondecade.org/wp-content/uploads/2018/03/UN-SG-Action-Plan_Water-Action-Decade-web.pdf (Accessed: 29 June 2022).
2. United Nations. (2022) Global issues. Water, https://www.un.org/en/global-issues/water.
3. World Health Organization (2022) Guidelines for drinking-water quality. Fourth edition incorporating the first and second addenda.
4. Organização das Nações Unidas. and Programa da Década da Água da ONU-Água sobre Advocacia e Comunicação (UNW-DPAC). (2010) 'O Direito Humano à Água e Saneamento Hoje', pp. 1–8. Available at: https://www.un.org/waterfor-lifedecade/pdf/human_right_to_water_and_sanitation_media_brief_por.pdf (Accessed: 20 June 2022).
5. United Nations. (2010) 'Resolution adopted by the General Assembly on 28 July 2010. 64/292. The human right to water and sanitation'.
6. United Nations. (2022) Sustainable development goals. Goal 6: Ensure access to water and sanitation for all., https://www.un.org/sustainabledevelopment/water-and-sanitation/.
7. World Health Organization (WHO) and United Nations Children's Fund (UNICEF)) (2021) Progress on household drinking water, sanitation and hygiene 2000-2020: Five years into the SDGs. Geneva.
8. Programa de las Naciones Unidas para el Medio Ambiente (2021) Progresos en la calidad de las aguas ambientales. Serie de seguimiento de los avances para la consecución del ODS 6: novedades sobre el indicador mundial 6.3.2 y necesidades de aceleración. Nairobi.
9. Frisbie, S. H. and Mitchell, E. J. (2022) 'Arsenic in drinking water: An analysis of global drinking water regulations and recommendations for updates to protect public health', PLOS ONE, 17(4), p. e0263505. doi: 10.1371/journal.pone.0263505.
10. Sarkar, B. et al. (2022) 'Drinking Water Quality and Public Health in the Kathmandu Valley, Nepal: Coliform Bacteria, Chemical Contaminants, and Health Status of Consumers', Journal of Environmental and Public Health, 2022, pp. 1–21. doi: 10.1155/2022/3895859.
11. Bain, R. et al. (2021) 'Monitoring Drinking Water Quality in Nationally Representative Household Surveys in Low- and Middle-Income Countries: Cross-Sectional Analysis of 27 Multiple Indicator Cluster Surveys 2014–2020', Environmental Health Perspectives, 129(9), p. 097010. doi: 10.1289/EHP8459.
12. Charles, K. J. and Greggio, E. (2021) 'Invited Perspective: Beyond National Water Quality Surveys: Improving Water Quality Surveillance to Achieve Safe Drinking Water for All (Sustainable Development Goal 6.1)', Environmental Health Perspectives, 129(9), p. 091301. doi: 10.1289/EHP10064.
13. Franco Netto, G. et al. (2017) 'Vigilância em Saúde brasileira: reflexões e contribuição ao debate da 1a Conferência Nacional de Vigilância em Saúde', Ciência & Saúde Coletiva, 22(10), pp. 3137–3148. doi: 10.1590/1413-812320172210.18092017.
14. Peters, M. et al. (2020) 'Chapter 11: Scoping Reviews', in JBI Manual for Evidence Synthesis. JBI. doi: 10.46658/JBIMES-20-12.
15. Salvador, P.T.C.O. et al. (2021) 'Contribuições da scoping review na produção da área da saúde: reflexões e perspectivas'. Rev. Enferm. Digit. Cuid. Promoção Saúde. 6, p.01-08. DOI:https://doi.org/10.5935/2446-5682.20210058

16.   Arksey, H. and O'Malley, L. (2005) 'Scoping studies: towards a methodological framework', International Journal of Social Research Methodology, 8(1), pp. 19–32. doi: 10.1080/1364557032000119616.

17.   Levac, D., Colquhoun, H. and O'Brien, K. K. (2010) 'Scoping studies: advancing the methodology', Implementation Science, 5(1), p. 69. doi: 10.1186/1748-5908-5-69.

18.   Peters, M. D. J. et al. (2020) 'Updated methodological guidance for the conduct of scoping reviews', JBI Evidence Synthesis, 18(10), pp. 2119–2126. doi: 10.11124/JBIES-20-00167.

19.   Lopes, R.H. et al. (2022) 'Surveillance of Drinking Water Quality Worldwide: Scoping Review Protocol.' International Journal of Environmental Research and Public Health vol. 19(15), p. 8989. doi:10.3390/ijerph19158989.

20.   Liberati, A. et al. (2009) 'The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: explanation and elaboration', BMJ, 339(jul21 1), pp. b2700–b2700. doi: 10.1136/bmj.b2700.

21.   Ouzzani, M. et al. (2016) 'Rayyan—a web and mobile app for systematic reviews', Systematic Reviews, 5(1), p. 210. doi: 10.1186/s13643-016-0384-4.

22.   Camargo, B. V. and Justo, A. M. (2013) 'IRAMUTEQ: Um software gratuito para análise de dados textuais', Temas em Psicologia, 21(2), pp. 513–518. doi: 10.9788/TP2013.2-16.

23.   Camargo, B. V. and Justo, A. M. (2021) Tutorial para uso do software Interface de R pour les Analyses Multidimensionnelles de Textes et de Questionnaires (IRAMUTEQ). Florianópolis.

24.   Choi, B. C. K. (2012) 'The Past, Present, and Future of Public Health Surveillance', Scientifica, 2012, pp. 1–26. doi: 10.6064/2012/875253.

25.   United States, Department of Health & Human Services and Centers for Disease Controle and Prevention (2022) Notifiable Infectious Disease Tables | CDC. Available at: https://www.cdc.gov/nndss/data-statistics/infectious-tables/index.html (Accessed: 29 June 2022).

26.   United States Environmental Protection Agency (US EPA) (2004) Understanding the Safe Drinking Water Act. . Available at: https://www.epa.gov/sites/default/files/2015-04/documents/epa816f04030.pdf (Accessed: 29 June 2022).

27.   Brasil. (1988). Constituição da República Federativa do Brasil de 1988. Diário Oficial da União 1988; 5 out

28.   Brasil. (2021). Portaria GM/MS nº 888, de 4 de maio de 2021. Disponível em https://bvsms.saude.gov.br/bvs/saudelegis/gm/2021/prt0888_07_05_2021.html

29.   Oliveira, A. de et al. (2019) 'Sistema de Informação de Vigilância da Qualidade da Água para Consumo Humano (Sisagua): características, evolução e aplicabilidade*', Epidemiologia e Serviços de Saúde, 28(1). doi: 10.5123/S1679-49742019000100024.

30.   Mora Alvarado, D. A. and Araya García, A. (2008) 'Estado del agua para consumo humano y saneamiento en costa rica al año 2007', Revista Costarricense de Salud Pública, 17(32), pp. 16–34.

31.   Porto, S. K. S. S. (2008) Controle e vigilância de trihalomethanos em água de abastecimento humano: o caso do desastre ambiental dos rios Pomba e Paraíba do Sul. Fundação Oswaldo Cruz.

32.   Motter, J. et al. (2011) 'Análise da concentração de flúor na água em Curitiba, Brasil: comparação entre técnicas', Rev Panam Salud Publica, 29(2).

33.   Teixeira ISC et al. (2012) 'Solução alternativa coletiva de abastecimento de água (SAC): avaliação da qualidade bacteriológica e da cloração. ', Rev Inst Adolfo Lutz, 71(3), pp. 514–19.

34.   Soares, N. C. F. B. (2015) VIGILÂNCIA DA QUALIDADE DA ÁGUA PARA CONSUMO HUMANO NO MUNICÍPIO DE SÃO LUÍS: análise de indicadores ambientais. . UNIVERSIDADE FEDERAL DO MARANHÃO.

35.   Vasconcelos, C. H. et al. (2016) 'Surveillance of the drinking water quality din the Legal Amazon: analysis of vulnerable areas', Cadernos Saúde Coletiva, 24(1), pp. 14–20. doi: 10.1590/1414-462X201500040142.

36.   Costa, F. da (2018) Qualidade físico-química e microbiológica da água consumida em Guaíba (RS) e sua implicação na saúde. Universidade Federal do Rio Grande do Sul.

37.   Romani, C. D. et al. (2018) 'Fluoretação das águas de abastecimento público: 10 anos de monitoramento em 38 municípios do Centro-Oeste Paulista, São Paulo, Brasil', Vigilância Sanitária em Debate, 6(4), p. 47. doi: 10.22239/2317-269x.01169.

38.   Queiroz, J. T. M. de, Heller, L. and Silva, S. R. da (2009) 'Análise da correlação de ocorrência da doença diarreica aguda com a qualidade da água para consumo humano no município de Vitória-ES', Saúde e Sociedade, 18(3), pp. 479–489. doi: 10.1590/S0104-12902009000300012.

39.   Edwards, J. E. et al. (2012) 'Characteristics of small residential and commercial water systems that influence their likelihood of being on drinking water advisories in rural British Columbia, Canada: a cross-sectional study using administrative data', Journal of Water and Health, 10(4), pp. 629–649. doi: 10.2166/wh.2012.046.

40.   Guzmán, B. L., Nava, G. and Díaz, P. (2015) 'Calidad del agua para consumo humano y su asociación con la morbimortalidad en Colombia, 2008-2012', Biomédica, 35(0). doi: 10.7705/biomedica.v35i0.2511.

41.   Ochoo, B., Valcour, J. and Sarkar, A. (2017) 'Association between perceptions of public drinking water quality and actual drinking water quality: A community-based exploratory study in Newfoundland (Canada)', Environmental Research, 159, pp. 435–443. doi: 10.1016/j.envres.2017.08.019.

42.   Castro, A. M. S. M. de and Câmara, V. de M. (2004) 'Avaliação do programa de vigilância da qualidade da água para consumo humano em Salvador, estado da Bahia. ', Rev. baiana saúde pública , 28(2), pp. 16–34.

43.   Abu Amr, S. S. and Yassin, M. M. (2008) 'Microbial contamination of the drinking water distribution system and its impact on human health in Khan Yunis Governorate, Gaza Strip: Seven years of monitoring (2000–2006)', Public Health, 122(11), pp. 1275–1283. doi: 10.1016/j.puhe.2008.02.009.

44. Mora-Alvarado, D. A. et al. (2019) 'Agua para consumo humano y saneamiento en Centros Educativos de Costa Rica al año 2017', Revista Tecnología en Marcha. doi: 10.18845/tm.v32i10.4876.

45. Gunnarsdottir, M. J. et al. (2012) 'Benefits of Water Safety Plans: Microbiology, Compliance, and Public Health', Environmental Science & Technology, 46(14), pp. 7782–7789. doi: 10.1021/es300372h.

46. Setty, K. E. et al. (2017) 'Water quality, compliance, and health outcomes among utilities implementing Water Safety Plans in France and Spain', International Journal of Hygiene and Environmental Health, 220(3), pp. 513–530. doi: 10.1016/j.ijheh.2017.02.004.

47. Penman, A. D., Brackin, B. T. and Embrey, R. (1997) 'Outbreak of acute fluoride poisoning caused by a fluoride overfeed, Mississippi, 1993.', Public health reports (Washington, D.C. : 1974), 112(5), pp. 403–9.

48. Elliot, A. J. et al. (2016) 'The potential impact of media reporting in syndromic surveillance: an example using a possible Cryptosporidium exposure in North West England, August to September 2015', Eurosurveillance, 21(41). doi: 10.2807/1560-7917.ES.2016.21.41.30368.

49. Ferretti, E. et al. (2010) 'A case study of sanitary survey on community drinking water supplies after a severe (post-Tsunami) flooding event.', Annali dell'Istituto superiore di sanita, 46(3), pp. 236–41. doi: 10.4415/ANN_10_03_03.

50. Queiroz, A. C. L. et al. (2015) 'Integrating surveillance data on water-related diseases and drinking-water quality; action-research in a Brazilian municipality', Journal of Water and Health, 13(4), pp. 1048–1054. doi: 10.2166/wh.2015.078.

51. Carvalho, A. P. M. et al. (2020) 'A vigilância em saúde ambiental como resposta ao desastre do rompimento da barragem de rejeitos em Brumadinho', Saúde em Debate, 44(spe2), pp. 364–376. doi: 10.1590/0103-11042020e225.

52. Iyer, V. et al. (2014) 'Drinking Water Quality Surveillance in a Vulnerable Urban Ward of Ahmedabad', Health, 06(11), pp. 1165–1171. doi: 10.4236/health.2014.611143.

53. Moore, A. C. et al. (1993) 'Surveillance for water-borne disease outbreaks--United States, 1991-1992.', MMWR. CDC surveillance summaries : Morbidity and mortality weekly report. CDC surveillance summaries, 42(5), pp. 1–22.

54. Centers for Disease Control and Prevention (CDC) (1994) 'Assessment of inadequately filtered public drinking water--Washington, D.C., December 1993.', MMWR. Morbidity and mortality weekly report, 43(36), pp. 661–9.

55. Centers for Disease Control and Prevention (CDC) (1998) 'Epidemic typhoid fever--Dushanbe, Tajikistan, 1997.', MMWR. Morbidity and mortality weekly report, 47(36), pp. 752–6.

56. Levy, D. A. et al. (1998) 'Surveillance for waterborne-disease outbreaks--United States, 1995-1996.', MMWR. CDC surveillance summaries : Morbidity and mortality weekly report. CDC surveillance summaries, 47(5), pp. 1–34.

57. Barwick, R. S. et al. (2000) 'Surveillance for waterborne-disease outbreaks--United States, 1997-1998.', MMWR. CDC surveillance summaries : Morbidity and mortality weekly report. CDC surveillance summaries, 49(4), pp. 1–21.

58. Lee, S. H. et al. (2002) 'Surveillance for waterborne-disease outbreaks--United States, 1999-2000.', Morbidity and mortality weekly report. Surveillance summaries (Washington, D.C. : 2002), 51(8), pp. 1–47.

59. Blackburn, B. G. et al. (2004) 'Surveillance for waterborne-disease outbreaks associated with drinking water--United States, 2001-2002.', Morbidity and mortality weekly report. Surveillance summaries (Washington, D.C. : 2002), 53(8), pp. 23–45.

60. Liang, J. L. et al. (2006) 'Surveillance for water-borne disease and outbreaks associated with drinking water and water not intended for drinking--United States, 2003-2004.', Morbidity and mortality weekly report. Surveillance summaries (Washington, D.C. : 2002), 55(12), pp. 31–65.

61. Yoder, J. et al. (2008) 'Surveillance for water-borne disease and outbreaks associated with drinking water and water not intended for drinking--United States, 2005-2006.', Morbidity and mortality weekly report. Surveillance summaries (Washington, D.C. : 2002), 57(9), pp. 39–62.

62. Brunkard, J. M. et al. (2011) 'Surveillance for water-borne disease outbreaks associated with drinking water---United States, 2007--2008.', Morbidity and mortality weekly report. Surveillance summaries (Washington, D.C. : 2002), 60(12), pp. 38–68.

63. McCarty, C. L. et al. (2016) 'Community Needs Assessment After Microcystin Toxin Contamination of a Municipal Water Supply — Lucas County, Ohio, September 2014', MMWR. Morbidity and Mortality Weekly Report, 65(35), pp. 925–929. doi: 10.15585/mmwr.mm6535a1.

64. Strosnider, H. et al. (2017) 'Rural and Urban Differences in Air Quality, 2008–2012, and Community Drinking Water Quality, 2010–2015 — United States', MMWR. Surveillance Summaries, 66(13), pp. 1–10. doi: 10.15585/mmwr.ss6613a1.

65. Sinyange, N. et al. (2018) 'Cholera Epidemic — Lusaka, Zambia, October 2017–May 2018', MMWR. Morbidity and Mortality Weekly Report, 67(19), pp. 556–559. doi: 10.15585/mmwr.mm6719a5.

66. Monti, M. M. et al. (2019) 'Community drinking water data on the National Environmental Public Health Tracking Network: a surveillance summary of data from 2000 to 2010', Environmental Monitoring and Assessment, 191(9), p. 557. doi: 10.1007/s10661-019-7710-y.

67. Aragonés Sanz, N. et al. (2001) '[Arsenic levels in drinking water supplies from underground sources in the community of Madrid].', Revista espanola de salud publica, 75(5), pp. 421–32.

68. Schuster, C. J. et al. (2005) 'Infectious Disease Outbreaks Related to Drinking Water in Canada, 1974–2001', Canadian Journal of Public Health, 96(4), pp. 254–258. doi: 10.1007/BF03405157.

69. Tabbot, P. N. and Robson, M. G. (2006) 'The New Jersey Residential Well-Testing Program--a case study: Randolph Township.', Journal of environmental health, 69(2), pp. 15–9.

70. Yassin, M. M., Amr, S. S. A. and Al-Najar, H. M. (2006) 'Assessment of microbiological water quality and its relation to human health in Gaza Governorate, Gaza Strip', Public Health, 120(12), pp. 1177–1187. doi: 10.1016/j.puhe.2006.07.026.

71. Zietz, B. P., Laß, J. and Suchenwirth, R. (2007) 'Assessment and management of tap water lead contamination in Lower Saxony, Germany', International Journal of Environmental Health Research, 17(6), pp. 407–418. doi: 10.1080/09603120701628719.

72. Sanders, A. P. et al. (2012) 'Arsenic in North Carolina: Public Health Implications', Environment International, 38(1), pp. 10–16. doi: 10.1016/j.envint.2011.08.005.

73. Knobeloch, L. et al. (2013) 'Private drinking water quality in rural Wisconsin.', Journal of environmental health, 75(7), pp. 16–20.

74. Oliveira, J. de S. C. et al. (2017) 'Soluções individuais de abastecimento de água para consumo humano: questões para a vigilância em saúde ambiental', Cadernos Saúde Coletiva, 25(2), pp. 217–224. doi: 10.1590/1414-462x201700020371.

75. Piorunneck, C. M. de O., Ditterich, R. G. and Gomes, E. C. (2017) 'Heterocontrole da fluoretação nos municípios da Região Metropolitana de Curitiba nos anos de 2014 e 2015', Cadernos Saúde Coletiva, 25(4), pp. 414–422. doi: 10.1590/1414-462x201700040171.

76. Pachá, A. S. C. (2018) Qualidade da água para consumo humano na Paraíba: Sistemas de Informações para fins de vigilância e controle das doenças diarreicas agudas. UNIVERSIDADE FEDERAL DA PARAÍBA.

77. Jones, M. C. et al. (2020) 'Arsenic Concentrations in Ground and Surface Waters across Arizona Including Native Lands', Journal of Contemporary Water Research & Education, 169(1), pp. 44–60. doi: 10.1111/j.1936-704X.2020.03331.x.

78. Khare, P. (2017) 'A large-scale investigation of the quality of groundwater in six major districts of Central India during the 2010–2011 sampling campaign', Environmental Monitoring and Assessment, 189(9), p. 429. doi: 10.1007/s10661-017-6130-0.

79. United Nations Children's Fund (UNICEF) and World Health Organization (WHO) (2021) The measurement and monitoring of water supply, sanitation and hygiene (WASH) affordability: a missing element of monitoring of Sustainable Development Goal (SDG) Targets 6.1 and 6.2. New York.

80. Rickert, B. et al. (2022) 'Indications of recent warm and dry summers' impact on private wells for drinking-water supply in Germany: a review of press articles', Journal of Water and Health, 20(1), pp. 167–175. doi: 10.2166/wh.2021.312.

81. Abdullahi, T., Nitschke, G. and Sweijd, N. (2022) 'Predicting diarrhoea outbreaks with climate change', PLOS ONE, 17(4), p. e0262008. doi: 10.1371/journal.pone.0262008.

82. Ikeda, T. et al. (2019) 'Climatic Factors in Relation to Diarrhoea Hospital Admissions in Rural Limpopo, South Africa', Atmosphere, 10(9), p. 522. doi: 10.3390/atmos10090522.

83. Centers for Disease Control and Prevention. and Office of Public Health Scientific Services. (2018) Public Health Surveillance: Preparing for the Future. Atlanta.

84. Voutchkova, D. D. et al. (2021) 'Estimating pesticides in public drinking water at the household level in Denmark', GEUS Bulletin, 47. doi: 10.34194/geusb.v47.6090.

85. Zini, L. B. and Gutterres, M. (2021) 'Chemical contaminants in Brazilian drinking water: a systematic review', Journal of Water and Health, 19(3), pp. 351–369. doi: 10.2166/wh.2021.264.

86. Carmo, E. H. (2020) 'Emergências de saúde pública: breve histórico, conceitos e aplicações', Saúde em Debate, 44(spe2), pp. 9–19. doi: 10.1590/0103-11042020e201.

87. Santos, R. et al. (2020) 'Vigilância em saúde e desastres de origem natural: uma revisão da literatura', Saúde em Debate, 44(spe2), pp. 316–333. doi: 10.1590/0103-11042020e222.

88. Mugadza, D. T. et al. (2021) 'Drinking water quality and antibiotic resistance of E. coli and Salmonella spp. from different sources in Gweru urban, Zimbabwe', Environmental Monitoring and Assessment, 193(8), p. 546. doi: 10.1007/s10661-021-09322-5.

89. Li, D. et al. (2021) 'Spatiotemporal evolution of groundwater nitrate nitrogen levels and potential human health risks in the Songnen Plain, Northeast China', Ecotoxicology and Environmental Safety, 208, p. 111524. doi: 10.1016/j.ecoenv.2020.111524.

90. Siegel, V. (2020) 'Risk Communication for Environmental Health Practitioners.', Journal of environmental health, 82(10), pp. 30–31.

91. United States et al. (2016) Drinking Water Advisory Communication Toolbox. .

92. Lindsey, M. et al. (2022) 'Insights into Improving Risk and Safety Communication through Environmental Health Literacy', International Journal of Environmental Research and Public Health, 19(9), p. 5330. doi: 10.3390/ijerph19095330.

93. Ebi, K. L. et al. (2020) 'Transdisciplinary Research Priorities for Human and Planetary Health in the Context of the 2030 Agenda for Sustainable Development', International Journal of Environmental Research and Public Health, 17(23), p. 8890. doi: 10.3390/ijerph17238890.

94. Roche, J. et al. (2020) 'Citizen Science, Education, and Learning: Challenges and Opportunities', Frontiers in Sociology, 5. doi: 10.3389/fsoc.2020.613814.

95. Biggeri, A. (2021) 'Citizen Open Science', Epidemiologia e prevenzione, 45(5), pp. 327–328. doi: 10.19191/EP21.5.P327.100.