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A literature review of waterborne outbreaks in the last decade in Türkiye

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Abstract

The present study aimed to evaluate the studies in the literature on waterborne outbreaks in the last decade. The literature was reviewed using the words "waterborne outbreak, outbreak investigation, Turkey and water" with PubMed, Google Scholar, and TR Index databases for the years 2010-2020. The 14 articles suitable for the outbreak review were reached and evaluated regarding the significant results. The responsible agents were determined as *Norovirus* in six studies, *F. Tularensis* in four, *Shigella spp*. in two, *Rotavirus* in one, and polymicrobial factors in one. In these outbreaks, 51,802 people were affected. Studies were descriptive, case-control, and retrospective cohort. The years with the highest number of outbreaks were 2014 (n=4) and 2010 (n=3). The largest outbreak was a Norovirus outbreak in the Elbistan district of Kahramanmaras, where 34,490 people were affected. In these outbreaks, 641 people received inpatient treatment, while no deaths were reported. In five of the outbreaks, the spots where the water was contaminated were detected, while they were not detected in nine. Failures in the water supply network, the lack of water tanks per the legislation, and the lack of chlorination for different reasons were determined to have caused waterborne outbreaks. Continuous water disinfection, overhauling non-compliance water tanks, timely maintenance and replacement of water networks, and strengthening communication between the institution responsible for water disinfection and health institutions can prevent waterborne outbreaks that could become a significant public health problem.

Keywords: systematic review, waterborne outbreak, Türkiye

1. Introduction

An outbreak is when more individuals are affected by an infectious disease than the usual frequency in a given time and population. For an infection to be qualified as an outbreak, the cases must be epidemiologically related and have at least two cases, whereas, for some infections, even a single case is defined as an outbreak (1, 2).

Poor sewage management, contamination of drinking water as a result of improper sanitation, and exposure to these waters both through consumption and during daily water use can lead to outbreaks that will create a heavy burden on population by bringing some bacterial, viral, and parasitological diseases as well as polluting the environment (3-5). Furthermore, the use of groundwater is common all over the world, especially in rural areas. These waters can be contaminated due to agricultural activities or sewer lines, and using water without treatment, believing it is safe, can lead to outbreaks (4, 6).

Safe drinking water, sanitation, and hygiene (WASH) are vital for human health. Although water-related diseases are very diverse, fecal-oral infections and diseases resulting from exposure to various chemicals and pollutants in drinking water are the leading ones. Other factors, such as climate change, population growth, rapid urbanization, or antimicrobial resistance, may exacerbate these diseases (7).

Waterborne diseases can cause acute gastroenteritis, acute respiratory syndrome, and some neurological disorders, as well as dehydration and electrolyte imbalances due to diarrhea, which can result in death (8). Most of these diseases are of microbiological origin, and some of the agents are *Rotavirus, Norovirus, Salmonella, Shigella, Hepatitis A,* Escherichia coli, *Campylobacter jejuni, Francisella Tularensis, Legionella pneumophila* and *Giardia intestinalis* (9, 10).

According to 2017 data, approximately 1.6 million people worldwide died from diarrheal diseases. In the same year, diarrhea was among the causes of death of one out of every ten children (10). Considering that approximately 88% of diarrhea-related deaths are caused by unsafe water, inadequate sanitation, and inadequate hygiene, it seems that these lives can be saved with simple and inexpensive interventions (11). In our country, waterborne outbreaks have occurred in different regions, and at times, many people have been affected (12-15).

The provisions of the legislation on spring water, drinking

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water, and potable-use water in Türkiye are determined by the "Regulation on Water Intended for Human Consumption." According to this regulation, the residual chlorine level should be 0.2-0.5 mg/L at the extreme point of the distribution network, and monthly residual chlorine measurement should be made in the effluent of the chlorinated tank. Calcium hypochlorite (solid), sodium hypochlorite (liquid), chlorine gas, chlorine dioxide, UV radiation, and ozone are used in water disinfection. The necessary criteria for selecting the disinfection method and the points to be considered are also determined in the legislation. Accordingly, the General Directorates of Water and Sewerage Administration of the Metropolitan Municipalities are responsible for selecting and implementing the appropriate disinfection method in the settlements within the borders of the Metropolitan Municipality. Municipalities are responsible in provinces that do not have metropolitan municipalities. Special Provincial Administrations are responsible for settlements outside the municipality's borders (16, 17).

Drinking water safety plays a significant role in establishing the quality of human life in societies. Waterborne outbreaks are caused by drinking water contamination worldwide. Emerging problems with microbial pathogens in drinking water can have a significant impact on public health. The present study aimed to evaluate the studies in the literature on waterborne outbreaks in the last ten years in Türkiye.

2. Materials and Methods

The data of the systematic review were obtained via the internet between January 15, 2021, and February 28, 2021. The literature was searched via PubMed, Google Scholar, and TR Dizin databases using the words "Waterborne outbreak," "Outbreak investigation," and " Turkey and water" for the years 2010-2020. Some studies were excluded from this study because 41 were same, and 131 were irrelevant. The remaining 84 studies were reassessed in terms of the study's inclusion and exclusion criteria. Case reports, case series, and studies in which the outbreak's source was not investigated were excluded. Among the accessed articles, 14 of which had a content suitable for the outbreak investigation were included in the study (Figure 1). The articles included in the research were evaluated in terms of the place and time of the outbreak, what the pathogens causing the outbreak were, what problems they caused, the leading causes of water pollution, the interventions to the outbreaks, the demographic data of the affected population and the critical results obtained from the studies.

Permission was obtained from the Ondokuz Mayıs University Clinical Research Ethics Committee (OMÜ KAEK 2020/733) for the study. Data were expressed as numbers and percentages.

3. Results

Of the 14 studies included, seven were case-control, six were descriptive, and one was a retrospective cohort study. All of the data in the studies were obtained through face-to-face questionnaires or hospital records.

While four outbreaks occurred in 2014, three in 2010, and two in 2012 and 2013, one was reported in 2015, 2016, and 2017. No studies published in the past three years were found. While most outbreaks occurred in districts and villages, only three occurred in provincial centers. *Norovirus* (Table 1) was held responsible in six of the outbreaks, *Shigella* (Table 2) species in two, *Rotavirus* in one, and polymicrobial agents (*Shigella sonnei, astrovirus, Norovirus, Rotavirus*) in one (Table 3), *F.Tularensis* (Table 4) in four. It was observed that all Norovirus outbreaks occurred in spring and summer, Tularemia in autumn and winter (except for one), *Shigella* in autumn, *Rotavirus* in spring, and polymicrobial outbreaks in winter months.

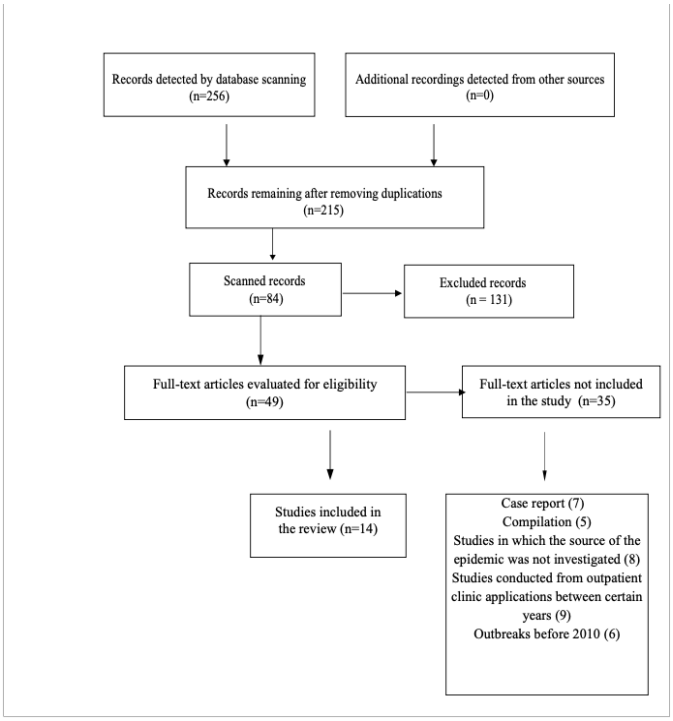

Fig. 1. Selection of studies flow diagram

Table 1. Summary of norovirus-borne outbreaks

Author, Time, Place Type of Study Data source	Characteristics of affected persons/ Complaint Hospital admission and hospitalization status Attack rates	Cause of the Outbreak	Outbreak response studies
Duman et al. (18). May 2014 Akharım, Afyon Case-control 292 cases 292 controls Questionnaire method with a face-to-face	395 suspected cases, 40.7% of probable cases were male, 59.3% female, Abdominal pain (89.8%), diarrhea (89.8%), nausea (80.9%), vomiting	The region has been rainy in recent months, Supplying water to the network system from surface sources, The presence	The waters were started to be chlorinated by an automatic chlorine device, Instead of the surface water source, water was supplied from deep water sources and

interview	(70.3%), fever (67.5%), other (8.1%), 16 people receiving inpatient treatment, the attack rate is 14.3%, the age group with the highest attack rate is 10-14, Norovirus was detected in two of the nine stool examinations, The virological analyzes could not be performed because the water samples taken were extremely dirty.	of cracks and leaks in the pipes, The water tank is not in compliance with the legislation, Water is given to the system without being subjected to chlorination.	given to the network system.
Şahan et al. (12). August 2016 Elbistan, Kahramanmaraş Descriptive Hospital records	34,490 people, 46% male, 54% female, 514 people receiving inpatient treatment, The attack rate is 20%, the age group with the highest attack rate is between 1-4 years old (41.9%), Norovirus was detected in the Ceyhan River, water resources, and irrigation canal, Norovirus was detected in three patients in stool samples taken.	Presence of irrigation water canals and sewerage systems close to water sources, Exposure of the mains water source to environmental pollutants, Insufficient water disinfection The water tank officer does not monitor the chlorine level and does not adjust the device.	A high level of chlorine was given to the network, Clay filling process was done on the riverside, The irrigation channel, which is thought to pollute the water resources, was canceled and covered with earth fill by pouring slaked lime on the ground, The sewerage network located near water sources such as the irrigation canal was also canceled and moved to another region.
Sözen et al. (19). April 2010 Keçiborlu, Isparta Descriptive Hospital records	1482 people, 41.6% male, 58.3% female, Nausea (90%), vomiting (70%), abdominal pain (90%), diarrhea (60%), fever (12%), Norovirus was detected in six of the stool samples taken from nine patients. Norovirus could not be detected in the samples taken in the city mains water, No hospitalization.	Precipitation of the region before the outbreak period, Water mains repairs in the region at that time.	Announcements were made to the public about the use of water after boiling, The training was given on personal hygiene and protection. Outbreak control was achieved in 13 days.

While a total of 51,802 people were affected in these outbreaks, the most affected were in the norovirus-borne outbreaks, with 43,263 people. The epidemic that affected the most people was the Norovirus epidemic that occurred in the Elbistan district of Kahramanmaraş with 34,490 people. In terms of age groups, it was observed that the attack rates were higher in children and young adults.

Table 1. (Cont'd.)

Author, Time, Place Type of Study Data source	**Characteristics of affected persons/ Complaint Hospital admission and hospitalization status Attack rates**	**Cause of the Outbreak**	**Outbreak response studies**
Duman et al. (18). May 2014 Akharım, Afyon Case-control 292 cases 292 controls Questionnaire method with a face-to-face interview	395 suspected cases, 40.7% of probable cases were male, 59.3% female, Abdominal pain (89.8%), diarrhea (89.8%), nausea (80.9%), vomiting (70.3%), fever (67.5%), other (8.1%), 16 people receiving inpatient treatment, the attack rate is 14.3%, the age group with the highest attack rate is 10-14, Norovirus was detected in two of the nine stool examinations, The virological analyzes could not be performed because the water samples taken were extremely dirty.	The region has been rainy in recent months, Supplying water to the network system from surface sources, The presence of cracks and leaks in the pipes, The water tank is not in compliance with the legislation, Water is given to the system without being subjected to chlorination.	The waters were started to be chlorinated by an automatic chlorine device, Instead of the surface water source, water was supplied from deep water sources and given to the network system.
Şahan et al. (12). August 2016 Elbistan, Kahramanmaraş Descriptive Hospital records	34,490 people, 46% male, 54% female, 514 people receiving inpatient treatment, The attack rate	Presence of irrigation water canals and sewerage systems close to water sources, Exposure of	A high level of chlorine was given to the network, Clay filling process was done on the riverside,

	is 20%, the age group with the highest attack rate is between 1-4 years old (41.9%), Norovirus was detected in the Ceyhan River, water resources, and irrigation canal, Norovirus was detected in three patients in stool samples taken.	the mains water source to environmental pollutants, Insufficient water disinfection, The water tank officer does not monitor the chlorine level and does not adjust the device.	The irrigation channel, which is thought to pollute the water resources, was canceled and covered with earth fill by pouring slaked lime on the ground, The sewerage network located near water sources such as the irrigation canal was also canceled and moved to another region.
Sözen et al. (19). April 2010 Keçiborlu, Isparta Descriptive Hospital records	1482 people, 41.6% male, 58.3% female, Nausea (90%), vomiting (70%), abdominal pain (90%), diarrhea (60%), fever (12%), Norovirus was detected in six of the stool samples taken from nine patients. Norovirus could not be detected in the samples taken in the city mains water, No hospitalization.	Precipitation of the region before the outbreak period, Water mains repairs in the region at that time.	Announcements were made to the public about the use of water after boiling, The training was given on personal hygiene and protection. Outbreak control was achieved in 13 days.

While chills-cold, sore throat, lymph node enlargement in the neck or around the ear, fever, muscle and joint pain, and headache were common in tularemia outbreaks; nausea, vomiting, abdominal pain, diarrhea, and fever were more frequent in others. While there were a total of 641 people who were admitted to the hospital for treatment, no fatal cases were reported. It was observed that the points where the water was contaminated in five outbreaks could be determined; in nine of them, it could not be detected. While no causative pathogen could be detected in water in the *Rotavirus, Shigella*, and Tularemia outbreaks, the causative pathogen could be detected in water in only one of the polymicrobial outbreaks and norovirus outbreaks.

Table 2. Summary of Shigella species-borne outbreaks

Author, Time, Place Type of Study Data source	**Characteristics of affected persons Complaint Hospital admission and hospitalization status Attack rates**	**The cause of the outbreak**	**Outbreak response studies**
Topal et al. (14). September 2012 Terme, Samsun Case-control 112 cases 112 controls Hospital records Questionnaire method with a face-to-face interview	4050 people Diarrhea (100%), fever (96.4%), abdominal pain (92.9%), nausea (86.6%), vomiting (80.4%), The attack rate was 9.2%, all age groups were affected by the disease, the 5-9 age group had the highest attack rate (18.7%), A total of 52 patients were hospitalized.	A broken water pipe was found near the water tank. Low chlorine levels (<0.2 ppm), Consuming only tap water increased the risk 2.0 (1.2-3.6) times, Culture results showed S. sonnei in 27 of 33 stool samples, total coliform in 18 of 52 water samples, and Escherichia coli in 4 of them.	The water mains system was examined and repaired.
Özüdoğru et al. (13). October 2014 Bayburt city center Case-control 247 cases, 247 controls Hospital records, Face-to-face survey form	971 people, 55.9% of cases were women, Diarrhea (100.0), abdominal pain (93.9), fever (81.0), nausea (74.5), vomiting (63.6), other (2.8), 23 people were hospitalized for treatment, Cases have been seen in all age groups, 68.0% of cases were under the age of 14, Attack speed 13.0 per thousand, Age groups with the highest attack rates were 0-14 years old (3,0%) and over 90 years old (3,3%)	It was observed that the free chlorine level in all samples was 0 (zero) ppm, In environmental examinations, it was seen that there was no chlorination device in the water tanks and there were rusted pipes, It was determined that there was water and sewerage works in Bayburt city center during the pre-outbreak period and intermittent water outages were made during this period. Before the outbreak period, there	Chlorination has been made in water networks, Public announcements were made to consume water by boiling and not to use tap water, 'Contaminated, undrinkable' statement was written on the fountains by the municipal teams.

		was moderate rainfall in the province.	

Lack of maintenance and control of chlorine tanks, interruption of chlorination as a result of power outages, presence of neighborhood fountain tanks near water channels, contamination of water tanks after heavy rainfall, reactions from the public due to changes in the taste of water with chlorination, and therefore interruption of chlorination, chlorination not being carried out regularly, water tanks not complying with the legislation, breaks and cracks in water pipes, sewer lines passing near water sources, positioning of water sources near environmental contaminants, contact of wild animals with water due to the absence of protection bands around water tanks, the use of unknown underground water sources in some fountains and insufficient chlorine levels in the waters and the miscommunication between the units responsible for water and health units were the main causes of these outbreaks.

Table 3. Summary of Rotavirus and polymicrobial-borne outbreaks

Author, Time, Place Type of Study Data source	**Number of people affected Complaints Hospital admission and hospitalization status Attack rates**	**The cause of the outbreak**	**Outbreak response studies**
Tozan et al. (20). March 2014 Nigde city center Case-control 88 possible cases 88 controls Hospital records Face-to-face survey form	1288 cases of acute gastroenteritis, Diarrhea (80.7%), abdominal pain (84.1%), nausea (89.8%), vomiting (84.1%), fever (55.7%), Coarse attack speed 10.9 per thousand The age group with the highest attack rate is 0-14 years, Five children were hospitalized. Rotavirus was detected in four of the six-stool samples taken.	Before the increase in the case, there was a water outage for two hours as a result of the power outage, and it was stated that there was light rain in the region on the same day, Insufficient chlorine levels were determined in the mains water samples taken during the outbreak, and the waters were found to be microbiologically unsuitable, It was found that the resulting rotavirus outbreak was caused by contaminated tap water and only tap water consumption was 6.5 (2.1-19.1), p<0.001 times risky, The contamination point of the tap water could not be determined.	Ensuring regular and effective disinfection of the mains water, checking whether the chlorination system works after the interruption, It was suggested that power outages and infrastructure works that may affect the network system should be made by informing the Public Health Directorate in advance, Also, it was suggested that microbiological examinations should be made by detecting the increase in cases and sufficient stool samples should be taken, and the patient's information should be recorded completely, accurately, and completely in Health Institutions.
Sezen et al. (21). December 2012 Erzurum Case-control 95 possible cases 95 controls Hospital records Face-to-face meeting	Number of cases 2096, 49% male, Diarrhea 92%, abdominal pain 86%, vomiting 85%, nausea 84%, fever 59%, other 6.4%, For the city center, the rate of gastroenteritis attack increases 5.6/1000, and the risk between the ages of 2-17 increases OR: 12 (3.3-42) times. Being male increased the risk by 5·6 (2·5-12) times.	It was determined that this outbreak was caused by ancient neighborhood fountains, It was determined that drinking water only from ancient neighborhood fountains increased the risk by 6·4 (3·0–16), The water flowing from these ancient fountains came from unknown underground sources, Of the eight stool samples collected, two were positive for Shigella sonnei, one for astrovirus, the other for astrovirus and Norovirus, and the other for astrovirus and Rotavirus.	A media campaign was organized to warn residents against the use of water from ancient neighborhood fountains, Later, the Provincial Directorate of Public Health initiated a construction project to supply the ancient neighborhood fountains with purified water from the municipal water treatment plant.

Table 4. Summary of tularemia-borne outbreaks

Author, Time, Place Type of Study Data source	**Number of people affected Complaints Hospital admission and**	**The cause of the outbreak**	**Outbreak response studies**

	hospitalization status **Attack rates**		
Boz et al. (22). January 2015 Dinar, Afyonkarahisar Case-control 29 cases 116 controls Face-to-face survey form	The number of cases was 29 people. 72.4% of the cases were women. Chills (89.7%), sore throat (86.2%), lymph node increase around the ear or neck (82.8%), fever (75.9%), muscle and joint pain (69%), headache pain (55.2%), other (10.3%), Although 62.1% of the cases were in the adult age group, cases have been seen in every age group, The oldest case was 72 years old, and the youngest case was five years old, with a mean age of 36.7±17.5 years.	It was found that drinking water from Tank-1 increased the estimated relative risk by 3.6 times in the case group compared to the controls, Although it was found that Tank-1 was the water source in the outbreak, the contamination point of the reservoir could not be found. Tularemia agent could not be detected in the water samples taken, No animal remains were found around the warehouses and in the main water source. Patients were diagnosed late, patients received different treatments for a long time, Since the first exposure period cannot be detected most of the time, it prevents sampling at the appropriate time and from the appropriate places.	The waters of the water tanks in the district were emptied and cleaned and offered for use again, The Public Health Directorate has increased the number of sampling points by tightening the water sampling periods, Physicians in the district were called by phone and informed.
Bozkurt et al. (23). October 21, 2013-January 22, 2014 Kahramanmaraş, Afşin Nadir village, Kargabükü village Descriptive Hospital records	10 patients, 5 (50%) men and 5 (50%) women, the age range of patients 2-68 (mean 25) years, F.tularensis antibody titers were found to be positive between 1/320-1/1280 bmicroagglutination test in serum samples of six out of ten cases, The oropharyngeal form of the disease was detected in all of the cases, and the coexistence of oculoglandular and oropharyngeal forms was observed in one.	Villagers stated that the sewerage system of the neighboring village passes 50 m above the village water tank, that there are leaks in the sewerage system, especially in rainy periods, and that they saw dead rodents in the water tank, None of the patients had a history of contact with rodent animals or their feces, There was no history of insect bites or ticks, contact with game animals, or eating wild animals. F.tularensis positivity was not observed in any of the water samples by PCR.	After the water tank was completely emptied and washed with chlorinated water, it was chlorinated at regular intervals, The villagers and the health center physician were informed about Tularemia.

4. Discussion

Five different factors [Norovirus, F. Tularensis, Shigella spp, Rotavirus, polymicrobial agent (Shigella sonnei, astrovirus, Norovirus, Rotavirus)] observed as the causative pathogens of the outbreaks between the years 2010-2020 were included in the study. Apart from these pathogens, waterborne outbreaks have occurred in Türkiye in the recent past with other factors. An outbreak occurred in a regional boarding school in Kahramanmaraş Central Karacasu town in May 2008, caused by pesticides mixed with the school's drinking water, and 51 children were affected by this outbreak. The contamination of the well water used by the school with pesticides as a result of the spraying of the agricultural lands around the school has been indicated as the cause of the contamination (29). Furthermore, the *Legionella* outbreak occurred in a newly opened hotel in Alanya, and six people were affected. The fact that the water temperature was in the range of 35-45 °C and the amount of iron in the water samples was too high to comply with the regulation paved the way for this outbreak (15).

In our study, the number of people affected by outbreaks ranged from 10 to 34,490 people. A study examining 15 outbreaks from four countries stated that between 47 and 400,000 people were affected by waterborne outbreaks (30). It is observed that there is a change in the number of people affected by these outbreaks according to the type of agent, the settlement where the outbreak occurred, the population of the region, the point where the water networks are contaminated, and when the outbreak prevention works were started. When the causative pathogen was examined, we determined that outbreaks caused by *Norovirus, Rotavirus*, and *Shigella* affect thousands of people in a short time, while Tularemia affects fewer people over a larger period.

Although no fatal cases were reported in the outbreak reviews included in the study, waterborne diseases can cause deaths. In the town of Walkerton, Ontario, Canada, 2300 people fell ill, and seven died after a heavy spring rain in May

2000. This outbreak was caused by *E. Coli 0157:H7* and *C. Jejuni* due to contamination of the water source by animal manure from a nearby farm (30).

From the studies examined, it has been observed that difficult and laborious epidemiological studies are performed to demonstrate that the source of the outbreak is water, to determine the contamination point of the water, to detect the causative pathogen, and to prevent the outbreak early. In nine of the studies examined, the inability to detect the contamination point of the waters delayed the response to the outbreaks. In most waterborne outbreaks, the causative pathogen could not be detected in the water. The cause of the outbreak was tried to be revealed according to the clinics, laboratory analyses, and stool examinations of the patients. These situations cause late intervention to outbreaks and increase the hospital burden in a short time with morbidities and financial losses.

There are various reasons why the agent cannot be obtained from water. Some of these are the late detection of the outbreak, the samples not being taken in the right amounts from the right places, the chlorination made without taking samples when it is understood that there is an outbreak and the absence of laboratories in every province where the samples will be studied. Moreover, the dilute presence of pathogens in water and technical difficulties (e.g., virus loss due to the membrane filtration process in cross-flow microfiltration and RT-PCR technique used in the detection of *Norovirus* and the need to take at least 100 liters of water sample from one point for norovirus detection) in microorganism production are obstacles to the detection of agents from water (31).

Most of the outbreaks we examined occur during periods of heavy rainfall. As a result of excessive precipitation events, fecal contamination of water resources by surface flow and soil movement, excess of the capacities of sewage systems, and discharge of untreated water into drinking water pipelines increase the risk of waterborne diseases in these periods by causing high microorganism density in the waters (32). For this reason, it is even more essential to perform water disinfection effectively and entirely and to take precautions during rainy periods.

It was observed in different studies that the microbiological pollution determined in drinking water in rural areas is higher than in urban areas. In a study in Edirne, 17.8% of the drinking water samples taken from rural areas were microbiologically contaminated, while 5.4% of the samples taken from urban areas were dirty (33,34). In our study, only three (21%) outbreaks occurred in provincial centers. A study investigating the effect of the New Metropolitan Municipality Law No. 6360 on microbiological contamination in water control indicated a positive change in microbiological pollution in drinking water, especially in rural areas in Tekirdağ province. With this law, the responsibility of delivering water to the consumers in a healthy way was transferred to the metropolitan municipality, while it was the special provincial administrations in the villages and the local municipalities in the towns, districts, and provincial centers. It was observed that the improvement in post-law outcomes is greater in rural areas with higher pollution than in urban areas (33). This result suggests that the disruptions that occur in rural areas can be eliminated by centralizing water management institutions, that is, by increasing investments from a single center in the provinces with a holistic approach.

In our country, water that provides less than 10 m3 of water per day or is used by a population of fewer than 50 people is not within the scope of the "Regulation on Water Intended for Human Consumption." In this regulation, it is recommended to inform the people of the region in case of any water contamination, to make recommendations to ensure the protection of public health, and to take the necessary precautions (16). Our study revealed that outbreaks occur mostly in districts and villages. There are neighborhood fountains and water tanks in rural areas in Türkiye, of which many unknown sources are available. Although the population in rural areas is less than in cities, people from the cities obtain drinking water from these fountains, thinking that the water in the village fountains is of higher quality and healthier. Thus, these waters are used by many more people. Continuous analysis and inspection of each source may bring some difficulties and deficiencies in terms of time, personnel, and finances. In these regions, water contamination can develop due to the lack of regular chlorination in the water tanks, the absence of automatic chlorination devices in the tanks, the chlorination being left to one of the village people, and the insufficient knowledge of these people about water disinfection.

A study in which the knowledge and awareness of village headmen in Bitlis province about the chlorination process were determined revealed that the rate of villages with water tanks was 95.3%, the rate of those tanks that comply with the legislation was 52.6%, the rate of those with chlorine devices was 12.2%, and the rate of warehouses where chlorination was performed was only 38.5% (35). This situation suggests a significant lack of legislation and information about water disinfection in rural areas.

Due to the change in the taste of water with chlorination in rural areas, there is a reaction from the public, and therefore chlorination is interrupted. In a study performed in the rural areas of Trabzon, 43.3% of the participants using a domestic water tank stated that the waters do not need to be chlorinated (36). A study on the village headmen of Bitlis indicated that the rate of the headmen who think that the water should be chlorinated is 79.3%. When asked why chlorine should not be added to water, 38.6% of them stated that "it spoils the taste of water," 22.7% said that "chlorine is poisonous," 2.7% said that animals do not drink chlorinated water," and 2.7% said that the chlorination process is challenging and laborious. Among the

headmen (%4.7) there were those who described chlorine as a poison decanted into water (35). Notably, these negative thoughts about water disinfection are at this level, even in a group that is a community leader.

Considering the causes of the outbreaks, general non-compliance with the legislation draws attention. When the outbreaks and the laboratory records of the water samples in that region are examined, it is observed that there were insufficient water chlorine levels and negative microbiological analyzes of the water in previous periods (21). In this respect, efforts should be made to identify and correct deficiencies individually. It should be ensured that devices are installed in water tanks where automatic chlorination devices are not available, additional power measures should be taken against possible power outages, and the necessary controls should be made by sharing the outage situations of electricity suppliers with the local administration and health directorates. Likewise, in the water network works to be conducted in a settlement, health institutions and the public should be informed, and to prevent possible outbreaks, it should be ensured that the water is not used as potable water for a while or it is boiled and consumed in case of contamination of the water after the outages.

This study has some limitations. Our study was carried out only on the data of related articles. For this reason, it cannot reflect the true extent of water-borne epidemics in Türkiye. In addition, insufficient number of related studies can be listed among the limitations.

In conclusion, when the characteristics of the outbreaks included in the study were examined, it was observed that due to the problems related to chlorination, disinfection per the legislation was not provided, there was still the use of neighborhood fountains, there was excessive precipitation, or there was insufficient communication between institutions in case of malfunctions related to the network system. To prevent outbreaks that occur mainly for preventable reasons, education should be provided to all segments of society on issues such as ensuring the water quality standards specified in our legislation, the use of healthy water, and hygiene. Local governments, special provincial administrations and headmen should fulfill their responsibilities more carefully in order to ensure the water quality standards specified in our legislation in order to prevent epidemics that occur mostly due to preventable reasons. Furthermore, effective and solution-oriented communication should be ensured with local governments, health institutions, and other relevant institutions to control the extraordinary situations that may arise and to overcome them with less damage.

Conflict of interest

The authors declared no conflict of interest.

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None to declare.

Authors' contributions

Concept: H.N.A., Ö.T., Design: H.N.A., Ö.T., Data Collection or Processing: E.A., Analysis or Interpretation: E.A., Literature Search:E.A., Writing: E.A., H.N.A., Ö.T.

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