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Research Article

Waterborne disease outbreak from drinking water contamination, Albania, July 2024: A case study

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Abstract

Most waterborne outbreaks are caused by faecal microbiological contamination, often detected through indicator organisms such as *Escherichia coli* and *Enterococcus* spp., which serve as reliable proxies for the presence of enteric pathogens. Noroviruses are widely recognized as a major viral cause of acute gastroenteritis and are frequently implicated in waterborne outbreaks due to their low infectious dose, environmental stability, and resistance to conventional water treatment processes.
This descriptive study aims to assess the public health impact of a waterborne outbreak linked to contamination of the water supply system in Bulqiza, Albania, during July 2024. Field investigations included microbiological and physicochemical analyses of drinking water, as well as measurements of residual chlorine levels. The strong spatiotemporal association between contaminated water and reported cases support a waterborne transmission route. A total of 441 gastroenteritis cases were reported, primarily among city residents (54.6%), with additional cases among daily commuters from surrounding villages (18.2%) and non-resident visitors (17.2%). The results revealed multiple violations of microbiological quality standards and a lack of residual disinfectant in several samples, indicating contamination of the water supply. Laboratory testing of patient specimens confirmed Norovirus GII as the primary aetiological agent. This outbreak highlights the critical need for reliable water infrastructure, consistent disinfection practices, and prompt public health responses. The findings emphasize the importance of sustainable water management, improved intersectoral coordination, and prevention strategies aligned with international water safety standards.

Keywords: outbreak, water contamination, Norovirus GII, public health, drinking water.

1. Introduction

Hygiene, sanitation, and water supply continue to have significant health implications even in developed countries. The active involvement of health professionals in these sectors is crucial to accelerating and consolidating progress in public health. Most outbreaks are caused by faecal microbiological contamination, often detected through indicator organisms such as *Escherichia coli* and *Enterococcus* spp., which serve as reliable proxies for the presence of enteric pathogens. Noroviruses are widely recognized as a major viral cause of acute gastroenteritis and are frequently implicated in waterborne outbreaks due to their low infectious dose, environmental stability, and resistance to conventional water treatment processes. According to the World Health Organization (WHO), waterborne diarrhoeal diseases cause an estimated 485000 deaths annually, highlighting the critical need for effective disinfection protocols and systematic water quality monitoring. In response, the WHO and the European Union have issued guidelines specifying acceptable microbiological and chemical thresholds for drinking water, including the continuous presence of free residual chlorine throughout the distribution network to ensure microbial control. However, in many municipalities across Albania and the Western Balkans region, implementation of such standards is hindered by infrastructure deficiencies, lack of real-time monitoring systems, and limited technical capacity. Additionally, unauthorized physical interventions in water supply pipelines, such as illegal tapping, structural damage, or post-treatment contamination, compromise system integrity particularly where hydraulic pressure is low and residual disinfectant is insufficient. These vulnerabilities increase the risk of microbial ingress and complicate the accurate identification of contamination sources during outbreak investigations. This study investigates an outbreak of acute gastroenteritis in the municipality of Bulqiza, Albania, during July 2024, which was epidemiologically and microbiologically linked to failures in drinking water safety. The investigation combines epidemiological analysis with microbiological and physicochemical testing of drinking water to characterize contamination patterns. It documents unannounced interventions in the water supply system and deficiencies in disinfection processes and evaluates the public health response and consequences of the outbreak. The findings aim to support municipal water security planning and guide structural interventions in water infrastructure, thereby enhancing preparedness for future outbreaks in similar settings.

2. Research Methods

This descriptive study was conducted in the municipality of Bulqiza, located in northeastern Albania, with a population of approximately 11,000 inhabitants. The area is served by a centralized drinking water system supplied by three underground sources. Water treatment is performed at two main depots, each serving different neighborhoods of the city, with chlorination carried out automatically. The distribution network consists of newly installed pipelines. The epidemiological field investigation employed structured questionnaires to collect relevant clinical data and information on direct exposures from affected individuals. The outbreak was examined in relation to the municipal water supply infrastructure through integration of spatiotemporal mapping of reported cases and water quality analyses. Water samples were collected from strategic points throughout the distribution network. Upon identification of suspected contamination, both sampling frequency and geographical coverage were increased. All sampling and transport procedures adhered to international standards. Alongside laboratory investigations, an assessment of the local water infrastructure was performed, focusing on the physical condition of pipelines, maintenance protocols, and potential cross-contamination risks. Additional data on water supply schedules, pressure fluctuations, and reported service interruptions were obtained in collaboration with the local water utility.

As part of the immediate public health response, residents were advised to avoid consumption of stagnant or untreated water. Health education initiatives were implemented to promote safe water practices, including the use of alternative water sources until safety was restored. The investigation was conducted in accordance with national public health protocols, led by the Institute of Public Health in collaboration with regional health authorities. All personal data were anonymized prior to analysis to ensure confidentiality. The study is based entirely on original field data, has not been published or presented elsewhere, and was carried out in line with national protocols and international standards for outbreak investigation and drinking water safety.

3. Analysis

Microbiological analyses included testing for total coliforms, *Escherichia coli* (E. coli), and enterococci using membrane filtration (0.45 **µm**), with results expressed as colony-forming units (CFU) per 100 mL. According to national and EU regulatory standards, all three indicators should be absent in safe drinking water. Physicochemical assessments comprised measurements of ammonium (NH_4^+), nitrite (NO_2^-), nitrate (NO_3^-), pH, and residual chlorine (Cl_2). Organoleptic characteristics, including odour, taste, turbidity, temperature, and colour, were also evaluated due to their influence on water acceptability for human consumption. Stool and rectal swab specimens underwent multiplex real-time RT-PCR analysis, which identified Norovirus GII as the primary etiological agent. Microbiological examination of stool samples from a subset of cases was conducted to confirm the viral aetiology.

4. Results

A total of 117 drinking water samples were collected and analyzed from the city's main distribution points during the outbreak. These samples came from households, bars, and restaurants. Of the samples tested, 17 were positive for *Escherichia coli*, 5 for coliform bacteria, while 22 samples showed no detectable residual chlorine at the time of analysis. The data showed a strong correlation between the lack of residual chlorine and increased microbial contamination, indicating chlorination failures and/or contamination in the distribution system. These findings are consistent with World Health Organization (WHO) guidelines, which emphasize the importance of maintaining residual chlorine levels throughout the water network to ensure microbiological safety. The physicochemical parameters of the water remained stable throughout the outbreak. Further environmental assessments identified systemic vulnerabilities. Although the water supply system contains new pipes installed in recent years, field observations revealed interference with the water supply network. Repairs to the water network and proximity to potentially contaminated areas increased the risk of exposure. These findings highlight the urgent need for increased monitoring, regular disinfection, and strict control measures to maintain water safety. During the outbreak, 441 cases of gastroenteritis were reported. The first patients presented to Bulqiza Hospital on July 6, 2024, with gastrointestinal symptoms including vomiting, diarrhea, fever, and abdominal pain. The affected population included local residents, visitors, and individuals from neighboring villages. A section of the main water network, recently repaired for a defect, located along roads commonly used by rural minibuses, was identified as a potential exposure point. Geographic analysis showed that 54.6% of cases originated from the city of Bulqiza, 17.2% from non-resident visitors, and 18.2% from surrounding villages with commuters (Figure 2). All patients received appropriate clinical care and were discharged from the hospital. Structured interviews using outbreak-specific questionnaires confirmed that the majority had consumed water from the water supply system, effectively ruling out foodborne transmission.

The epidemic curve (Figure 3) revealed an abrupt onset with a sharp peak of 62 cases on July 7, 2024, followed by a gradual decline. This pattern strongly supports waterborne transmission. Cases included all age groups (1 to 82 years), with the 15–44 age group representing 40.3% of cases (Figure 4). The gender distribution was approximately balanced, with a slight female predominance (52.6%), potentially related to household water exposure. Vomiting was the most prevalent symptom (53%), followed by diarrhea (26.7%), fever (12.4%), epigastric pain (11.7%), and nausea (2.3%) as detailed in Table 1

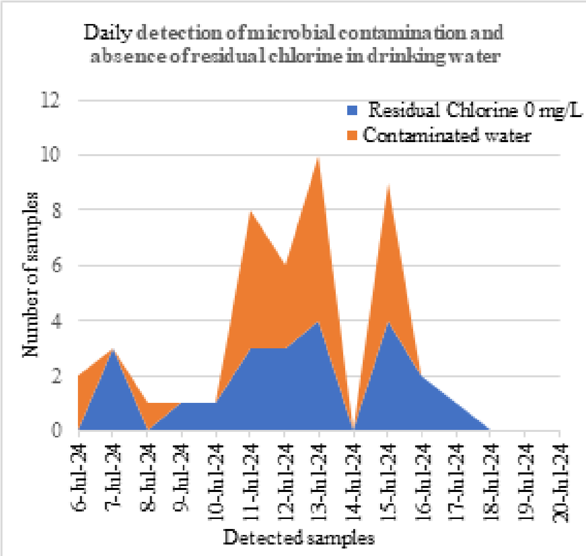

Figure 1. Daily detection of microbial contamination and absence of residual chlorine in drinking water

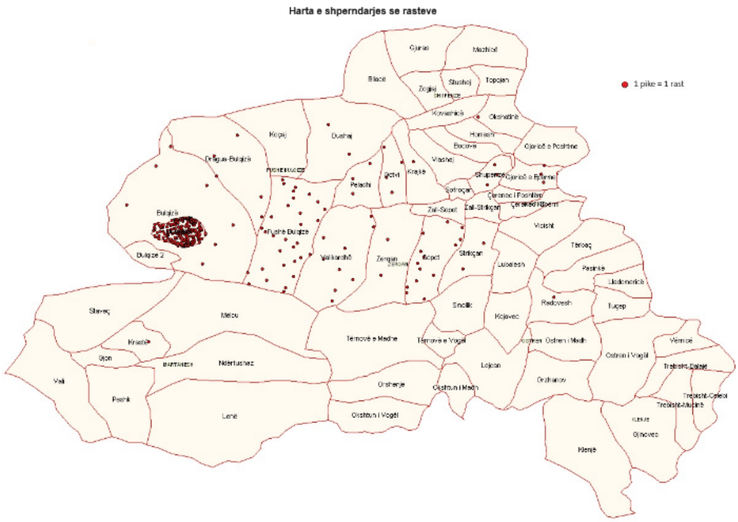

Figure 2. Geographical distribution of gastroenteritis cases presenting to the emergency service during the outbreak in Bulqiza and surrounding areas

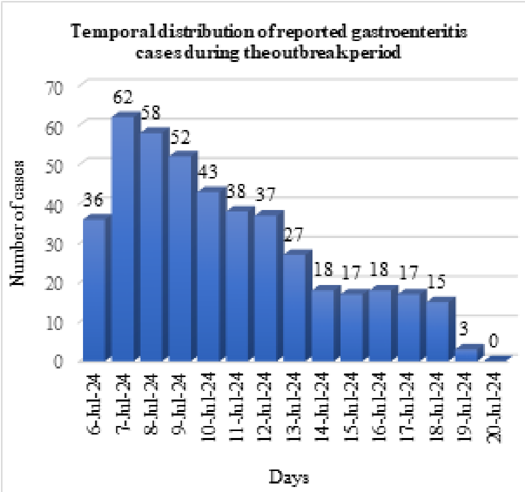

Figure 3. Temporal distribution of reported gastroenteritis cases during the outbreak period

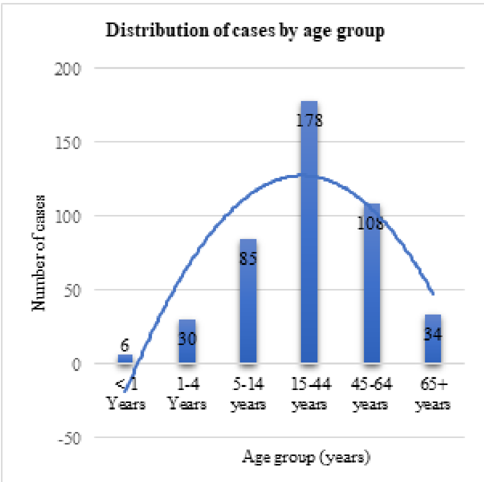

Figure 4. Age distribution of gastroenteritis cases reported during the outbreak period

Table 1. Distribution of clinical symptoms among gastroenteritis cases during the waterborne disease outbreak

Clinical symptom	Number of cases	Percentage (%)
Vomiting	234	53.0%
Diarrhoea	118	26.7%
Fever	55	12.4%
Epigastric pain	52	11.7%
Nausea	10	2.3%

Vomiting was the predominant clinical symptom, and cases were distributed across all age groups, indicating widespread exposure likely linked to the central water supply. Physicochemical and microbiological analyses identified significant failures in the water safety chain. Several samples showed absence of residual chlorine and elevated faecal indicators, suggesting critical deficiencies in disinfection and monitoring.

5. Conclusion

These findings are consistent with international reports linking viral gastroenteritis outbreaks to inadequate chlorination, pipeline damage, and unauthorized interventions in water networks. Insufficient residual chlorine, as emphasized by the World Health Organization, compromises microbial control in public water systems and is a well-recognized risk factor for the spread of enteric viruses. Environmental and technical factors played a pivotal role in the outbreak dynamics, with elevated summer temperatures likely facilitating increased transmission among the exposed population. These shortcomings highlight the urgent need for rigorous operational maintenance protocols to prevent cross-contamination during routine or emergency repair activities.

Public education and behavioural change remain essential components of outbreak management. Improving household hygiene, enhancing risk communication, and fostering public trust in health advisories are crucial to mitigating the impact of such events. Awareness campaigns, particularly in the early stages of an outbreak, can substantially reduce exposure and transmission. This investigation also underscores the importance of intersectoral collaboration. Rapid response and effective coordination among health authorities, municipal water providers, and environmental agencies were critical in containing the outbreak. Preventing future waterborne epidemics requires sustained investment in water infrastructure, strict enforcement of disinfection standards, and proactive monitoring of water quality indicators year-round.

The acute gastroenteritis outbreak in Bulqiza was confirmed to be caused by Norovirus

GI, Norovirus GII, and Sapovirus, which further substantiated the viral etiology and waterborne transmission. Norovirus GII was directly linked to microbiological contamination of the municipal drinking water supply. This investigation highlights the critical importance of ensuring access to microbiologically safe drinking water. Prevention strategies should prioritize strengthening disinfection protocols, enhancing routine water quality surveillance, and reinforcing emergency preparedness and public health risk communication.

Additionally, the potential for cross-contamination between drinking water and wastewater infrastructure emphasizes the need for systematic monitoring and physical separation of pipelines. At points where drinking water and wastewater pipelines intersect, appropriate containment and engineering safeguards must be implemented to prevent backflow and pathogen infiltration. This event further demonstrated the crucial role of institutional coordination across health, environmental, and water supply sectors in managing waterborne outbreaks and ensuring the long-term sustainability of the system. Future investigations should include direct molecular detection of viral pathogens in water samples to improve source attribution and support refinement of water safety plans. Strengthening the regulatory and operational frameworks governing drinking water infrastructure is essential to prevent future outbreaks and safeguard public health.

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