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Drinking Water Safety: A Surveillance-Based Assessment in Dibra, Albania

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ABSTRACT: Drinking water quality is a critical determinant of public health, especially due to the risk of waterborne diseases when safety parameters are compromised. Among these diseases, gastroenteritis has significant epidemiological importance and is usually caused by exposure to contaminated food or water, or through close contact with infected individuals. The cross-sectional study, conducted in the Municipality of Dibra during 2024, aimed to investigate the relationship between water quality and the incidence of gastroenteritis. The findings revealed that diseases with possible transmission through drinking water accounted for 57.8% (3886/6727) of all annual morbidity cases, and gastroenteritis accounted for 99.8% (3879/3886) within the group of waterborne diseases. The distribution by gender showed that 51.8% of cases occurred in males and 48.2% in females. A total of 3353 drinking water samples were analyzed for microbiological indicators, while 5874 samples were examined for physicochemical parameters. Overall, 99% of the samples met the microbiological standards, but 217 water samples were found to be out of range for the physicochemical indicator. These results highlight the importance of maintaining rigorous water treatment protocols to minimize the risk of disease transmission. Residual chlorine levels were measured in 5869 water samples. Of these, 30 samples had 0 mg/L residual chlorine, indicating a lack of disinfectant, while 469 samples showed low levels, indicating insufficient chlorination. Fluctuations in these levels highlighted gaps in the disinfection process.

KEYWORDS: Gastroenteritis, risk factors, water samples, waterborne diseases, public health.

1. INTRODUCTION

Ensuring access to safe drinking water remains a fundamental global public health priority. Inadequate water treatment and distribution infrastructure continues to significantly contribute to the transmission of gastrointestinal infections, which are frequently linked to microbial contamination in drinking water sources (1). Dibra is located in northeastern Albania and is characterized by mountainous terrain and limited infrastructural coverage. These environmental and demographic factors increase the population's vulnerability to contaminated water. Recurrent outbreaks of waterborne diseases in the area highlight the need for improved surveillance and targeted interventions (2). The water supply in the Municipality of Dibra is sourced from the Korab, Grama, and Luznia springs. These springs were selected for the study as they represent diverse topographical and demographic conditions within the region. By assessing water quality parameters within these systems and analyzing their association with reported gastroenteritis cases, this study seeks to provide evidence to inform improved water safety planning and health risk mitigation strategies in similar mountainous settings.

2. MATERIAL AND METHODS

A cross-sectional study was conducted over a 12-month period in 2024. Dibra was chosen as the study site due to the critical need to investigate the relationship between drinking water quality and disease incidence in settings characterized by infrastructural limitations and increased vulnerability to waterborne infections. Inadequate water quality continues to contribute significantly to the burden of communicable diseases, particularly among vulnerable populations (3). A total of 3353 water samples were analyzed for microbiological indicators and 5874 for physicochemical parameters, in addition to 5869 residual chlorine measurements Epidemiological and environmental data sets were analyzed in parallel to explore temporal and spatial correlations between fluctuations in water quality and reported disease cases. This integrative approach would enable the identification of potential causal pathways and recommendations for targeted interventions in water safety management (4). Specifically, the methodology followed the provisions of the Albanian national standard for drinking water monitoring, as defined in Decision No. 379, which is harmonized with the European Drinking Water Directive (5). Sampling protocols were in accordance with ISO for microbiological and physicochemical assessments of water quality (6). To better characterize deviations from acceptable water quality standards, a specific category of "abnormal water quality samples" was defined for analytical purposes (7). Water disinfection in the study area is carried out through a manual chlorination process, which required measurements of the residual chlorine level within the distribution network (8). Microbiological testing was performed in accordance with ISO 9308 and World Health Organization (WHO) guidelines (9). Epidemiological data were cross-analyzed with water quality monitoring results to identify temporal and spatial trends, and to investigate possible associations between abnormal water quality indicators and disease incidence (10).

3. RESULTS

3.1 Water Quality Indicators:

Residual chlorine levels were adequate in 91.3% of samples, while 8% showed levels <0.5 mg/L and 0.5% had no detectable chlorine. Only 9 samples (0.2%) exceeded recommended levels. Ammonium exceedances (0.15%) were reported in August. 716 water samples were reported for abnormal parameters, including color, odor, taste, turbidity, and chlorine deficiencies.

3.2 Disease Incidence and Seasonality:

Out of 6727 disease cases, 3886 (57.8%) were potentially waterborne, 3879 of which were gastroenteritis. Gender distribution was 51.8% male and 48.2% female. Case peaks were observed in August and October, aligning with periods of abnormal water quality.

3.3 Correlation between Quality and Disease:

Temporal overlap between low residual chlorine and spikes in gastroenteritis cases suggests a strong link. Inadequate chlorination, especially during warmer months, highlights the need for more consistent disinfection practices.

4. FIGURES AND TABLES

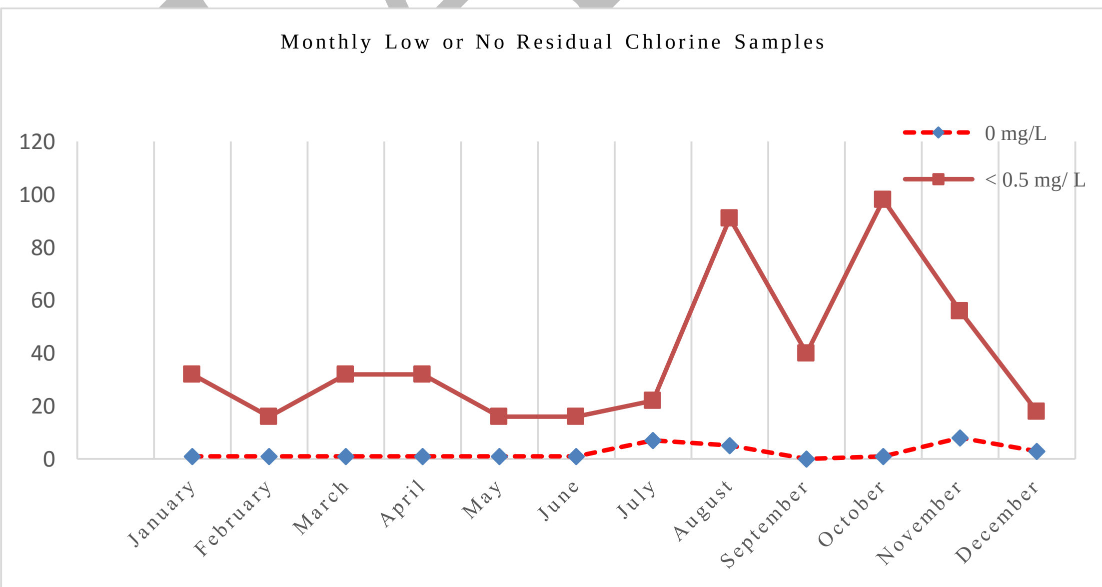
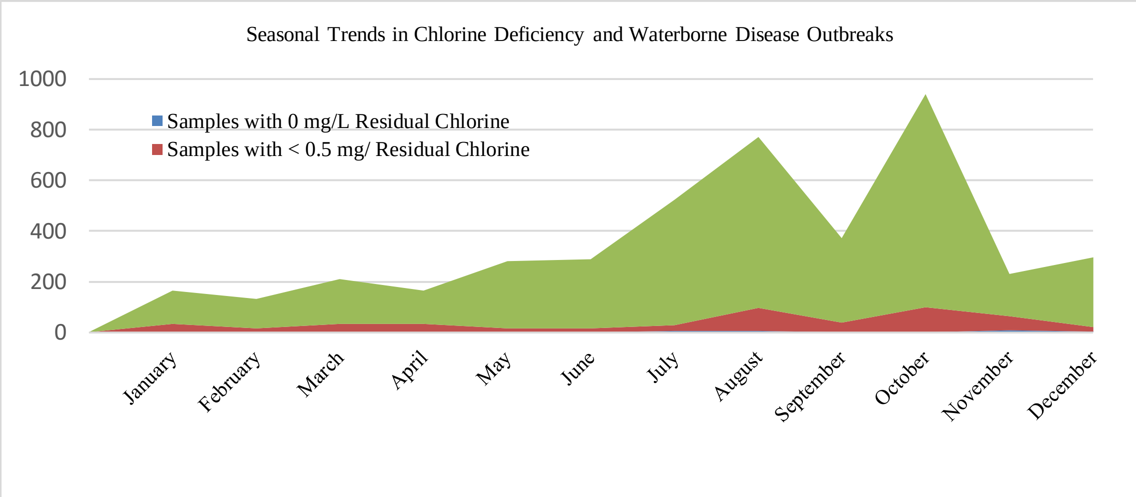


Fig.1 Monthly distribution of water samples with low (<0.5 mg/L) or no (0 mg/L) residual chlorine

Fig.2 Temporal Overlap Between Low Residual Chlorine Levels and Reported Gastroenteritis Cases



5. CONCLUSION & FUTURE SCOPE

During this year-long study in the Municipality of Dibra, we closely examined the relationship between drinking water quality and gastroenteritis cases. Although our laboratory results indicated that microbiological indicators largely fell within acceptable standards, the public health data revealed a different perspective. Of the 6727 reported illness cases, 57.8% (3886/6727) were classified as gastroenteritis, suggesting a significant waterborne component. This was particularly notable given the very low number of samples testing positive for key microbial indicators such as E. coli (11). These findings raise important questions about potential sources of contamination beyond the central water supply system, possibly involving private wells, inadequate household water storage, or secondary contamination following distribution. Moreover, fluctuations in residual chlorine levels especially the consistently lower values recorded in the afternoon highlight systemic operational deficiencies in the disinfection process. The continued reliance on manual chlorination appears insufficient. These discrepancies underscore the urgent need for automated systems capable of maintaining stable residual chlorine concentrations throughout the day. This is not only a technical challenge but also a public health imperative (12). The findings also emphasize the need for continuous surveillance beyond the main distribution network, as well as risk communication with the population regarding point-of-use water treatment. Ultimately, the high burden of gastrointestinal illness calls for expanded surveillance efforts, targeted outreach to households using alternative water sources, and further investigation into contamination risks outside the formal supply infrastructure, and targeted interventions in high-risk months.

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