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THE ROLE OF OPEN WATER SOURCES AS A TRANSMISSION FACTOR IN THE ETIOLOGY OF INFECTIOUS ACUTE INTESTINAL DISEASES

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Abstract. *According to the analysis of scientific sources, water-related factors have a significant impact on human health and the spread of infectious diseases. According to the World Health Organization, 70–80% of infectious diseases worldwide are associated with poor drinking water quality and non-compliance with sanitary and hygienic standards. Open water sources and outdated water supply systems are particularly dangerous, as they serve as the main factors in the transmission of acute intestinal infections (AII). Microbiological and virological contamination of drinking water poses not only an epidemiological threat but also has long-term negative effects on the health of the population, especially children. High rates of diarrhea and AII are most often recorded in countries in Africa, South and Central Asia. In Central Asia, the lack of access to safe drinking water, the failure of water sources to meet sanitary requirements, and the effects of climate change contribute to the intensified spread of intestinal infections. In the case of Uzbekistan, climate change, drought, and the deterioration of sanitary and epidemiological conditions lead to persistently high rates of diarrhea and AII among children. The etiology of waterborne infections is dominated by viral (rotavirus, norovirus, adenovirus) and bacterial pathogens (Salmonella, Shigella). These findings highlight the need to ensure access to safe drinking water, strengthen sanitary and hygienic measures, and develop preventive strategies considering climatic factors.*

Keywords: *drinking water, water contamination, acute intestinal infections, climate change, sanitation, epidemiology, Central Asia.*

Introduction. According to scientific sources, numerous studies have reported the impact of water-related factors on the spread of infectious diseases [6,7]. According to the World Health Organization (WHO), 70–80% of all communicable diseases worldwide are associated with poor drinking water quality and violations of sanitary and hygienic standards in water supply systems [1,2]. In recent years, due to the aggravation of global water-related problems, issues of sustainable water supply have begun to be regarded by states as matters of national security (Rafiev H. et al., 2017) [9].

Currently, the issue of providing the population with safe drinking water is becoming increasingly urgent. Moreover, the contamination of water sources, the deterioration of sanitary and epidemiological conditions, and the unsatisfactory technical state of water supply systems have led to an increase in the incidence of waterborne intestinal infections (Klein S.V. et al., 2017) [1,10].

The majority of these cases (about 90%) occur in regions where sanitation, hygiene, and water supply systems are insufficiently developed, particularly in sub-Saharan Africa and South Asia. Furthermore, diarrhea affects children's health not only through mortality but also through its long-term negative consequences. It contributes to growth retardation and developmental delays, as well as an increased susceptibility to chronic diseases later in life [2].

Scientific evidence confirms that the long-term consumption of drinking water with a high level of microbiological (virological) contamination leads to an increase in infectious diseases among both adults and children (Bobun I.I. et al., 2016). Among waterborne infectious diseases, acute intestinal infections (AII) are the most prevalent, particularly those transmitted through contaminated open water sources. According to the World Health Organization (WHO), more than 1 billion cases

of acute intestinal infections (AII) are registered worldwide each year, and 65–70% of these cases occur among children under the age of five [2,3,4,5,19,20,21,22,33].

Acute intestinal infections represent a major global threat to child health. According to the analysis of the "Global Burden of Disease Study," which covered 195 countries in 2016, diarrhea was identified as one of the leading causes of death among children under five years of age (Volkova G.S. et al., 2021), accounting for approximately 446,000 deaths worldwide.

According to Buzinov R.V. (2011), the microbiological contamination of drinking water represents a significant problem in hygiene and epidemiology. In many cities, the use of contaminated surface water has led to a shift from traditional waterborne diseases (such as cholera, typhoid fever, and dysentery) to viral and parasitic infections, including hepatitis A, serous meningitis, and giardiasis. Therefore, drinking water is always considered epidemiologically hazardous. Ensuring the supply of microbiologically and virologically safe drinking water is crucial for reducing waterborne infections and preventing mass outbreaks of infectious diseases [16].

An analysis of the literature indicates that in many regions of Russia, the quality of drinking water from supply sources and water pipelines raises serious concern (Bobun I.I. et al., 2016). According to Maksim Egorov (2023), 87.5% of the Russian population is provided with centralized, high-quality drinking water. In practice, however, almost all water supply sources in Russia are subject to varying degrees of anthropogenic and technogenic impact. The highest levels of pollution have been observed in the basins of the Volga, Don, Irtysh, Neva, Tobol, Tom, Northern Dvina, and several other rivers [15,16].

In France, approximately 99.7% of the population uses safe and regulated drinking water services (2022).

We also attempted to analyze the issues related to providing the population with safe drinking water in the countries of Central Asia. According to data from Rafiev H.K. and co-authors (2001) [11], bacteriological testing of water samples from the drinking water supply network serving 67% of the rural population of the Republic of Tajikistan revealed that 93% of the samples did not comply with sanitary rules and standards (SanRandS). The quality of non-centralized water supply sources was also extremely poor, with coliform index values ranging from 240 to 2400 and higher [12].

According to Rafiev H.K. and co-authors (2017) [9], as a result of implementing the National Program for Improving Access to Safe Drinking Water for the Population of the Republic of Tajikistan for 2008–2020, by 2015, a significant portion of the population had gained access to high-quality drinking water. This achievement is of particular importance from the standpoint of preventing some of the "costliest" diseases for society—such as typhoid fever, bacterial dysentery, fecal–oral transmitted hepatitis, and acute intestinal infections (AII) [13,14,15].

According to Omarova A. and co-authors (2019), in the Republic of Kazakhstan, approximately 90% of the urban population has access to safe drinking water, whereas in rural areas this figure is only about 28% [18].

According to A. Madreimov and co-authors (2011), the population's access to drinking water in the Republic of Karakalpakstan (RK) was 60% (72% in urban areas and 47% in rural areas). More recent data from A. Madreimov and co-authors (2024) indicate that, as of January 1, 2022, 69.7% of the RK population was provided with centralized drinking water, including 72.4% in urban areas and 27.6% in rural areas [6,17]. These figures suggest that nearly 40% of the population of Karakalpakstan still relies on water from open reservoirs and wells.

According to Egemberdieva A.D. (2025), the Mailuu-Suu River in the Kyrgyz Republic is characterized by a high risk of microbiological and technogenic contamination. These risks play a significant role in the occurrence of waterborne intestinal infections and cancer diseases [23]. According to data provided by the National Statistical Committee of the Kyrgyz Republic, 96.3% of the country's population currently has access to safe drinking water sources [24].

In Uzbekistan, 81.5% of the population is provided with a centralized drinking water supply [25]. It should be noted, however, that the population, particularly those living in rural areas, is insufficiently supplied with high-quality drinking water. The incidence rate of diseases among rural residents is reported to be 2.0–2.5 times higher than that of the urban population (Rafiev H.K. et al., 2001) [11]. Therefore, ensuring access to safe drinking water for the population is of great importance in preventing acute intestinal infections (AII).

The Impact of Climate Change on Intestinal InfectionsEnvironmental factors play a crucial role in water contamination. Considering this, a hypothesis has been proposed suggesting that climate change, along with harmful environmental and hygienic factors—particularly those related to water, can be regarded as one of the main factors influencing the spread of intestinal infections. Therefore, we attempted to analyze the interrelationship among certain adverse environmental factors based on scientific sources [4].

According to research findings, climate change affects human health throughout the entire lifespan — from infancy and adolescence to old age. These changes intensify hydrological variability and increase both the frequency and severity of extreme weather events such as floods and droughts. Consequently, the risk of food- and waterborne intestinal infections also rises.

A positive correlation has been observed between environmental temperature and bacterial diarrhea, while a negative correlation has been reported with viral diarrhea (particularly rotavirus-associated gastroenteritis). A decrease in rainfall contributes to the accumulation of pathogens in water sources, thereby increasing the risk of diarrheal diseases. Similarly, heavy rainfall and flooding can elevate this risk by spreading sewage and animal waste across the environment.

The relationship between rainfall and diarrhea risk is complex, with varying results reported across different studies. Some studies have found associations with both low and high rainfall levels, while others have reported correlations only at moderate or extreme rainfall levels.

Drought is a complex ecological phenomenon that cannot be defined merely by low precipitation or high temperatures. Although the World Meteorological Organization (1992) defined drought as a “prolonged absence or sharp reduction of summer rainfall,” in recent years, it has been emphasized that this definition should also consider water supply and demand factors. However, there is still no universally accepted scientific definition of drought. As a result, studies assessing the relationship between complex drought indices and diarrhea risk have produced inconsistent conclusions.

In a recent spatiotemporal analysis conducted in Afghanistan, the “aridity index”—defined as the ratio of daily minimum temperature to humidity—was used as a drought indicator, and a positive correlation was identified between this index and diarrheal incidence [29]. To date, this study remains the only one to assess the relationship between complex drought measures and diarrhea risk in this manner.

Ante-Testard and co-authors (2024) analyzed the interactions between climatic factors, diarrheal cases, and socio-economic conditions, emphasizing that these interactions can significantly influence the effectiveness of WASH (Water, Sanitation, and Hygiene) interventions among vulnerable populations. For example, in Bangladesh, during the monsoon season, heavy rainfall has been shown to increase the incidence of diarrhea among children born in rural areas. Therefore, the importance of interventions aimed at reducing diarrheal outcomes following extreme weather events has been particularly highlighted [26].

The Impact of Climate Change on Intestinal Infections in UzbekistanAccording to Vafokulov S.Kh. and co-authors (2025), the Republic of Uzbekistan is characterized by a high birth rate, significantly exceeding that of Russia, Europe, and the United States. The country’s geographical location and sharply continental climate create favorable conditions for the spread of certain infectious diseases, including diarrheal illnesses among children [30].

The widespread occurrence of intestinal infections in Uzbekistan is associated with the region's natural and climatic characteristics, highlighting their socio-economic significance. According to data from the State Epidemiological Service of the Republic, in 1988, there were 141,515 registered cases per 100,000 population, of which 26,470 were laboratory-confirmed. In 1998, this figure decreased to 66,933 cases (12,074 confirmed), and by 2017 it further declined to 43,864 cases (7,727 confirmed) [31].

It is well known that acute intestinal infections (AII) remain one of the most significant social and medical problems in Uzbekistan. The emergence and persistence of this issue are largely influenced by factors such as the provision of the population with high-quality drinking water, the efficient use of water resources, and the implementation of sanitary and hygienic education programs (Salomova F. et al., 2022) [32].

Waterborne Intestinal Diseases: Epidemiological Significance and Factors of Distribution. The level of access to safe drinking water for the population is primarily determined by the condition of water supply sources and their compliance with hygienic standards. The impact of water resources on public health and living conditions is influenced by numerous factors, including the region's climatic conditions, sanitary status, accessibility of safe drinking water, and the technical condition of water treatment facilities and distribution networks—all of which play a crucial role in this process [15].

General Characteristics of Waterborne Infections. Many epidemiological situations associated with enteric viruses are characterized by transmission through water. Such cases have been identified both in open water reservoirs and in urban water supply systems, confirming the significant role of water factors in the spread of infections. According to studies conducted in Ukraine and other CIS countries, antigens of enteric viruses are frequently detected in drinking water samples [4–8,10].

According to historical data, the concentration of viral antigens in drinking water increased during epidemic years. For example, in 2008, the incidence of rotavirus infection was particularly high, while in 1994, cases associated with viral hepatitis A (VHA) were more prevalent. During the period from 1994 to 2008, contamination of water with the VHA antigen decreased from 52.6% to 2.7%, which was found to correlate with a reduction in disease incidence ($r = 0.72$; $p < 0.05$) [34].

The relationship between water quality and public health.Human health is closely linked to the quantity and quality of available water resources. In low-water years, the quality of the Amu Darya River deteriorates due to an increase in collector–drainage water inflow, rendering the water unsuitable for drinking purposes. The number of water pollutants has risen dramatically over the past half-century—from 17 to more than 2,500 types—posing a serious threat to both ecosystems and public health.An analysis of population morbidity dynamics indicates that, although official statistics show a decline in incidence rates, this trend may be attributed to a low level of medical reporting and healthcare-seeking behavior [1].

Routes of infection and epidemiological characteristics.

According to sanitary-epidemiological assessments, the waterborne route plays a leading role in the transmission of dysentery, accounting for more than 90% of cases. Contact-household transmission was observed in 6.2% of cases, while foodborne infection occurred in 3.8% of cases. Under the influence of water-related factors, *Shigella flexneri* dysentery predominated, representing 75–85% of all cases. In contrast, *Shigella sonnei* dysentery was less common and primarily recorded in rural areas, accounting for about 10–15% of cases. Although official data indicate a decline in dysentery incidence since 2003, this trend is believed to be associated with a reduction in the number of people seeking medical assistance rather than an actual decrease in disease occurrence [11].

Epidemiological situation in rural areas.

High incidence rates have been recorded in rural settlements, reflecting the continuous activity of waterborne factors. Epidemic outbreaks typically occur in regions that rely on surface water bodies,

particularly irrigation systems. Rafiev Kh.K. and co-authors (2001) noted that such situations are more frequently observed in areas where the sanitary protection of water sources is insufficient [11].

Analysis of waterborne transmission in foreign countries.

Studies conducted in the United States and several European countries (France, Austria, Sweden, and the Netherlands) have demonstrated a correlation between the amount of consumed water and the risk of infection. It was found that regular consumption of 2 liters of water containing *aero-* and *pseudomonads* may increase the risk of intestinal colonization up to 100 times above the minimal threshold [36].

Water supply systems and epidemic situations.

The largest outbreaks of Acute Intestinal Infections (AII) associated with water are typically caused by contamination of centralized water supply systems. These incidents are usually linked to sanitary and technical deficiencies, pipeline deterioration, and insufficient sealing. During periods of water shortage, a pressure drop can allow infectious agents from the surrounding soil to infiltrate water pipelines. This is especially likely to occur when the sanitary distance between sewage and water pipes does not meet regulatory standards [3].

The Significance of Seasonality and Climatic Factors in Waterborne Intestinal Diseases.

Acute waterborne intestinal infections (AII) are closely associated with the population's sanitary and hygienic conditions, climatic characteristics, and seasonal variations. Changes in water temperature, rainfall, and human dietary habits influence the activity and spread of infections. According to scientific sources, viral enteric infections—especially among children—exhibit pronounced seasonality, with their prevalence varying according to climatic conditions.

Epidemiological observations indicate that pathogen transmission depends on both season and climate. For example, rotavirus infections are more common in winter months, whereas norovirus infections are observed primarily during the autumn–winter season [33,37]. Throughout all seasons, diseases associated with hepatitis A virus (HAV), rotavirus, adenovirus, and enterovirus predominate [34].

During the winter season, norovirus infections accounted for 52% of all gastroenteritis cases, while rotavirus infections also manifested in epidemic patterns [37]. Moreover, rotavirus infections showed higher activity from March to May, whereas norovirus and adenovirus activity peaked in autumn and winter ($P < 0.001$; $P = 0.016$; $P = 0.002$).

These data indicate that seasonal factors—particularly decreasing temperatures and increasing humidity—favor the prolonged survival of viruses in the environment and facilitate rapid infection spread.

Analysis of the transmission routes of acute intestinal infections (AII) revealed that cases occurred through:

- Foodborne transmission: 53.8%
- Waterborne transmission: 17.9%
- Household/contact transmission: 28.3%

Among foodborne sources, fruits and vegetables were identified as the most hazardous, accounting for 59.1% of cases. These foods are often consumed after being washed with contaminated water or left damp, increasing the likelihood of infection.

Waterborne cases accounted for 17.9% of the total, indicating that virological and bacteriological control of drinking water remains insufficient.

Household or contact transmission (28.3%) primarily occurs when hygienic practices are not observed, particularly affecting young children and groups in childcare institutions, where infections can spread rapidly.

Risk Factors for Acute Intestinal Infections in Young Children.

A survey conducted to identify transmission factors of acute intestinal infections (AII) in young children revealed the following:

- 41.7% of affected children were artificially fed,
- 62.9% had an unhealthy premorbid background, indicating generally poor health,
- 22.2% experienced frequent diarrhea during the month preceding the onset of illness.

Additionally, interviews with caregivers indicated:

- In 56.5% of cases, the child's diet had changed in the week prior to illness onset,
- In 4.4% of cases, the illness was associated with the consumption of mixed food products,
- In 8.5% of cases, maternal diet disturbances were noted [35].

Geographical Characteristics of Seasonal Distribution.

The seasonality of acute intestinal infections (AII) is particularly pronounced during the hot summer months, when a large portion of the population relies on surface water sources. This situation can lead to epidemiological activity lasting more than six months in valley regions. In autumn, the epidemiological situation becomes even more complex, as rainfall and the wet season cause sewage and wastewater to enter surface water bodies, increasing the level of contamination. This creates conditions for the prolonged survival of viruses and bacteria in the natural environment. For example, in 2015, an epidemic of viral AII was observed in the village of Mnogovershinnoye, Nikolaev District, which was linked to water contamination during the snowmelt period [38]

Etiological Composition of Waterborne Intestinal Diseases.

Waterborne infections, particularly acute intestinal infections (AII), pose a serious threat to children's health. These infections are caused by a variety of microorganisms—viruses, bacteria, and parasites—which enter the human body through drinking water or food products and disrupt normal intestinal microflora function.

Currently, rotaviruses and noroviruses occupy the primary role in the etiology of AII. At the same time, bacterial diarrhea, especially that caused by Salmonella and Shigella, remains significant. Studying the etiological structure of AII pathogens is crucial for identifying infection sources in children, strengthening epidemiological surveillance, and developing effective preventive measures [5].

Role of Bacterial Agents.

Analysis of scientific sources indicates that Salmonella enteritidis is the primary causative agent in bacterial acute intestinal infections (AII), accounting for 99.7% of all cases. S. typhimurium was detected in only one patient. These findings are consistent with published data and confirm the leading role of S. enteritidis in the etiology of AII among children.

Age-group analysis revealed that Salmonella infections were most common in children aged 3–6 years (26.2%) and 7–17 years (23.1%).

In the etiology of shigellosis, the Shigella sonnei biovar "k" predominated, accounting for 10.6% in group II and 13.2% in group III.

Cases of escherichiosis caused by *Escherichia coli* were primarily detected in children under 2 years old (0.8%), which can be explained by the underdeveloped immune system in this age group and the higher likelihood of infection through contaminated water [19].

Predominance of Viral Agents.

Among viral intestinal infections, rotaviruses occupy a leading position. Their detection rate decreases with age:

- Group I (under 2 years): 99.3%
- Group II (3–6 years): 99.2%
- Group III (7–17 years): 92.8%

This pattern is associated with the development of immunity to the virus as children grow. Studies conducted in the United States have also shown that 75–90% of acute gastroenteritis cases in children are caused by viral infections, with rotavirus being the predominant pathogen. Bacterial infections account for 10–20% of cases, while parasitic infections comprise less than 5% [33].

Currently, rotavirus, norovirus, astrovirus, and adenovirus 40/41 are recognized as the main causative agents of viral gastroenteritis in children. These viruses demonstrate high prevalence in both industrialized and developing regions.

Research highlights that norovirus and rotavirus are frequently implicated in water-related outbreaks, emphasizing that virological monitoring of drinking water is a crucial component of AII prevention [37].

Pathogenic Mechanisms of Viruses.

Viruses affect intestinal epithelial cells, causing varying degrees of inflammation and absorption disorders:

Rotavirus – a double-stranded RNA virus that damages small intestinal enterocytes, leading to villus atrophy and malabsorption. NSP4 enterotoxin disrupts calcium homeostasis, resulting in secretory diarrhea (Esona & Gautam, 2015; Fallah et al., 2023). Norovirus – a single-stranded RNA virus that binds to histo-blood group antigens on intestinal epithelial cells, causing inflammation and motility disturbances (Karst & Tibbetts, 2016). Sapovirus – damages epithelial cells, impairing nutrient absorption (Oka et al., 2015). Adenovirus (40/41) – a double-stranded DNA virus that induces cytopathic effects and inflammatory responses in the intestinal mucosa (Damavand et al., 2013).

Conclusion. Based on the analysis of scientific sources, it can be concluded that microbiological and virological contamination of water sources, the technical condition of water supply systems, and violations of sanitation and hygiene standards contribute significantly to the increase in infections. This situation is especially pronounced in developing countries, rural areas, and regions with extreme climatic conditions.

Climate change, drought, reduced rainfall, and contamination of water resources act as ecological factors that enhance the spread of intestinal infections. The relationship between climatic conditions and epidemiological patterns has been demonstrated, with extreme weather events leading to increased cases of diarrhea and viral gastroenteritis.

Furthermore, in parts of the Asian region, including Uzbekistan, Kazakhstan, Tajikistan, and Kyrgyzstan, water supply is insufficient in certain areas, particularly in rural regions, and microbiological monitoring of drinking water is limited, resulting in high rates of acute intestinal infections (AII) among children.

In conclusion, ensuring safe and high-quality drinking water, strengthening sanitation and hygiene measures, and developing preventive programs that take climate change into account are of decisive importance in preventing waterborne infections.

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