

DYNAMICS OF INFECTIOUS DISEASES RELATED TO THE MICROBIAL QUALITY OF THE WATERS OF THE IONIAN SEA, SARANDA REGION, ALBANIA

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ABSTRACT

The health of people is seriously threatened by bacteria found in recreational waters. When people use these water sources for bathing and other purposes during the tourist season, this hazard is more noticeable, and the issue is made worse. This study examined bacterial and fungal diseases in humans believed to have their source in the Saranda region's surface waters over the years 2022–2023. Water's microbiological purity is crucial for lowering present and potential health hazards. Saranda lies in the south of Albania and is washed by the Ionian Sea. During the summer, when the population grows several times, it is one of the most popular tourist destinations. Analysis from the Bacteriological Laboratory of the Saranda Regional Health Directorate showed that bacterial and fungal infections increased in the summer. The analysis of water taken from three of the most well-known seawater spots in the baths also showed contamination levels over the permitted limits for fecal indicators, fecal coliforms, and fecal streptococcus. By establishing a link between infectious diseases and surface water microbiological pollution, we concluded that bacterial and fungal infections were more prevalent during the tourist season. According to taxonomic analysis, bacterial infections were more common than fungal ones. The most prevalent illness brought on by contaminated water.

Keywords: Escherichia coli, Saranda region, Streptococcus sp., surface waters, urinary tract infections

INTRODUCTION

Saranda is a tourist city that, geographically, lies on the Ionian coast, near the Mediterranean coast, located in the southernmost part of Albania. It has a favorable position for tourism, as it has easy access to the sea with wonderful views and is rich in recreational waters. Saranda is one of Albania's most popular tourist sites, attracting a considerable number of visitors from within and outside the country each year. The population of Saranda is relatively small compared to other tourist cities in Albania. In recent years, the number of residents has increased

significantly due to the economic development of the area as a result of tourism development. Its population multiplies during the summer season. The main economic and cultural activities in Saranda and the surrounding areas, which rely on and affect surface waters, include tourism as a key sector, which is closely influenced by surface water for both beaches and coastal-water activities, as well as cultural tourism. Agriculture is another sector where surface waters are used for irrigation systems for agricultural lands around Saranda. On the other hand, seawater is used not only as a tourist attraction but also as a source of money for fishermen, transforming it into a valuable economic resource for the local community and others. All of these economic activities are inextricably related to surface water resources and have a significant impact on both the area's economic development and public health. As a result, protecting and maintaining the quality of these surface waterways is critical to the development of the region. Surface water pollution can occur for various reasons, including discharged and untreated wastewater, which may contain parasites, bacteria, fungi, or even viruses; agricultural and livestock waste, which may contain pesticides as well as animal bacteria; rainfall that may bring pollution of animal origin.

These factors, including anthropogenic impacts, have a significant impact on surface water quality and consequently on public health. A wide range of gastrointestinal disorders are caused by poor water quality and the presence of pathogens in water. In general, discharges of wastewater contaminated with human or animal feces into freshwater and coastal waters increase the risk of infectious diseases, including pathogens (Fenwick 2006; George & Servais 2001; Grabow WOK 1996; WHO 2008). Children under the age of fifteen and the elderly over sixty years of age are among the most affected by diarrheal diseases. Gastrointestinal infections are a serious threat to public health and affect a large number of individuals, accounting for about 3.4 million deaths globally each year. These figures come from data from the World Health Organization in 2003, which estimated that the cause was the spread of infections from pathogens closely associated with water (Seas et al., 2000).

According to the study, gastrointestinal infections are the most prevalent transmitted by water. The spread of pathogenic bacteria such as *Escherichia coli* (*E. coli*), *Klebsiella*, *Proteus*, etc. can cause inflammation and infection in the intestines. These infections are often accompanied by symptoms such as diarrhea, vomiting, and stomach pain and, in severe cases, can cause dehydration and serious complications. (George & Servais 2002; Grabow WOK. 1996; Medema et al., 2003; Payment et al., 2003; Scheutz & Strockbine 2005; WHO 2008).

Urinary tract and skin infections can be caused by bacteria and fungus such as *Escherichia coli*, *Enterococcus*, and *Candida albicans*, which enter the human body via polluted water (Grimont F, & Grimont PAD. 2003; Grimont PAD & Grimont F. 2005).

MATERIALS AND METHODS

This study included the analysis of samples from healthy and sick patients brought to the Bacteriological Laboratory at the Saranda Regional Health Directorate for suspected gastrointestinal, urinary, and skin fungal bacterial infections originating from polluted surface waters in the years 2022-2023. The study included 5391 individuals aged 0-15 years to 60 years and older. The data were statistically processed using the Excel application.



Figure. 1. Manual register sheet and data from the electronic register

For each patient, the name, surname, gender, age, date, month, and year of sample collection; the type of sample obtained; and the response, consisting of the type of infection, were recorded (Figure 1).

Patients were sorted into two groups based on the type of infection they had, females and men, and then regrouped according to age groups: 1-15 years, 16-25, (age groups were divided into 10-year-olds) until the last group, which

is 66 years and older. Positive cases were analyzed for each month of the two-year study. Each culture, such as urine, vaginal secretions, feces, cocci bacteria, or candida mold, was analyzed based on sex and age group. In the laboratory for assessing urine culture samples, a standard, well-defined procedure/protocol was followed, described as follows in Figure 2:



Figure 2. Urocult Analysis Procedures Manual Sheet

Protocol for Urine Culture

The patient brings the morning sample to the microbiology laboratory (instant urine, the second portion of the first morning urine) in a sterile glass. It must be brought to the laboratory within two hours, and the urine cultures of the “Urikult” media are processed at the moment. After being submerged in the urine sample, the Urikult media is incubated for 24 hours at 37°C in a thermostat. E. coli, Enterococcus, Pseudomonas, Proteus, or any other urinary infection is differentiated based on the results of the incubation process.

Protocol for Vaginal in Women and Urinary Cultures in Men

There are particular swabs for urethral cultures in men and vaginal cultures in women. The swabs must be sterile. The material in the swabs is then spread on blood agar plates and simultaneously on Sabouraud's glucose agar (Merck, Germany) (Dalynn Biologicals <https://www.dalynn.com>) for four days, aerobically. The blood agar medium is a special medium for itself, while Sabouraud is a special medium for molds. After carefully observing the spread of the material on the respective medium, it is placed in a thermostat and incubated at 37°C for 24 hours. Following the incubation period, the results are evaluated, and the cocci are differentiated to determine their kind, also for molds.

RESULTS AND DISCUSSIONS

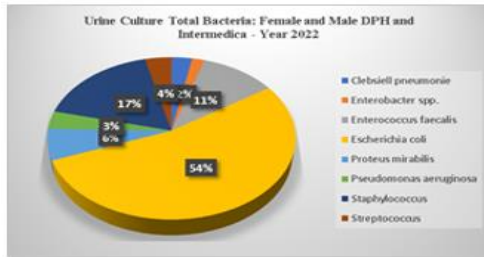
From this study, it was observed that there is a correlation between human infection and disease rates and bacterial indicators SF/CF in water, which is most noticeable during the summer season, a period that coincides with the tourist season. Based on the results shown in Tables 1 and 2, it resulted that out of 5391 tests, 849 patients in total tested positive for urinary tract infections during the two years of the study 2022-2023. The predominant cases were infections caused by *Escherichia coli*, with 455 cases, or 54.00%. Following *E. Coli* were 147 cases (17.3%) of *Staphylococcus bacterium* and 92 cases (11%) of *Enterococcus faecalis*. *Enterobacter* results in a lower number, with only 15 patients in total, or 2.9%.

Table 1. Urine culture-Total number of bacteria by age group (female and male) for 2022.

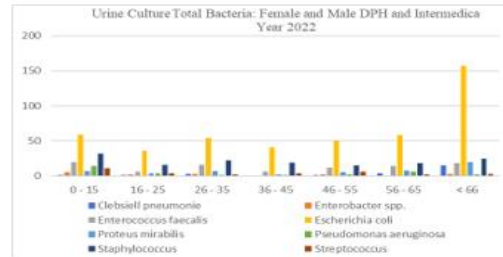
Urine Culture Total Bacteria: Female and Male DPH and Intermedica - Year 2022									
Age group	Total positive	Clebsiell pne umonie	Enterobacter spp.	Enterococcus faecalis	Escherichia coli	Proteus mirabilis	Pseudomonas aeruginosa	Staphylococcus	Streptococcus
0-15	149	1	5	20	59	7	14	32	11
16-25	73	1	2	6	36	4	4	16	4
26-35	108	3	3	16	54	7	1	22	2
36-45	73	0	0	6	41	2	1	19	4
46-55	93	1	2	12	50	5	2	15	6
56-65	110	4	0	14	58	8	6	18	2
<66	243	15	3	18	157	20	2	25	3
Total	849	25	15	92	455	53	30	147	32

Table 2. Urine culture-Total number of bacteria by age group (female and male) for 2023.

Urine Culture Total Bacteria: Female and Male DPH and Intermedica - Year 2023										
Age group	Total positive	Enterobacter spp.	Enterococcus faecalis	Escherichia coli	Klebsiella pneumoniae	Proteus mirabilis	Pseudomonas aeruginosa	Staphylococcus	Streptococcus	
0-15	102	0	18	35	5	6	9	9	20	
16-25	56	0	7	18	2	5	2	7	15	
26-35	124	0	20	49	6	10	2	25	11	
36-45	123	0	13	65	3	14	8	15	5	
46-55	76	0	2	39	5	11	2	10	7	
56-65	123	0	9	70	11	8	7	13	5	
<66	273	0	41	165	13	23	8	18	5	
Total	877	0	110	411	45	77	38	98	68	

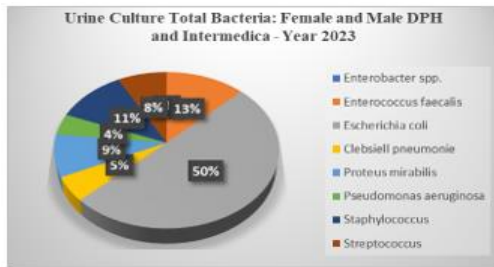


(1)

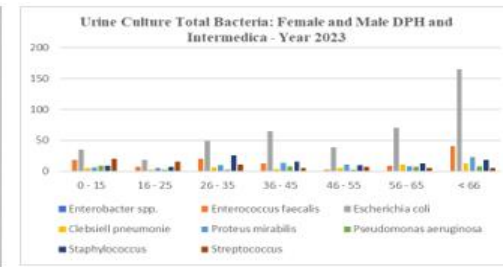


(2)

Figure 1 and 2. Dynamics of bacterial species by age group (female and male) for 2022.



(3)



(4)

Figure 3 and 4. Dynamics of bacterial species by age group (female and male) for 2023.

Under Table 1 and figure 1 and 2, the age group 66 and older is the most affected, followed by 0–15 and 26–35 years old. The age categories of 16–25 and 36–45 were the least impacted. Also for 2023, the most affected age group is over 66 years old, while the least affected is 46 to 55 years old (Table 2 and figure 3 and 4).

We examined the spread of various infections by month of the year in order to comprehend the link between high levels of surface water pollution and human infections. Regarding 2022, it turns out that the number of bacterial illnesses is higher in the summer months (July with 102 patients and August with 93 patients, which also corresponds with the summer season) than in any other month. With 62 patients, E. coli is the most prevalent bacterium. This rising number over the summer is also consistent with the fact that this coastal region has a rather large population at this time of year. (Refer to figure 5.)

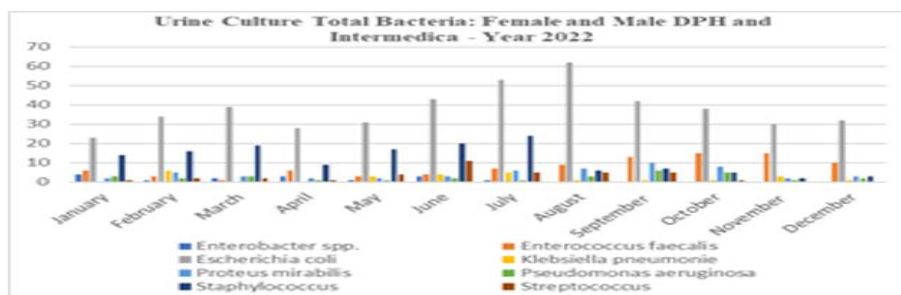


Figure 5. Dynamics of bacterial species by month (female and men) for 2022.

Furthermore, seafood consumed during this time is not always inspected by accredited institutions or laboratories. They are consumed directly from the sea to the dinner table. Regarding 2023, it turns out that the most patients (118–101) are afflicted with the bacteria *E. coli* and *Enterococcus faecalis* in the months of September and October. The months of July and August also show high values. (Refer to figure 6).

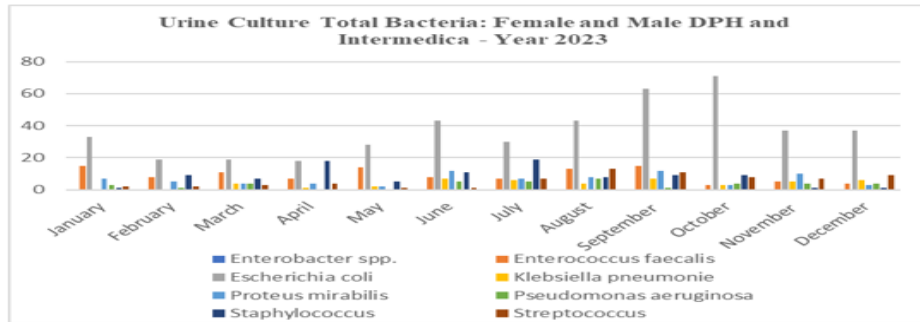


Figure 6. Dynamics of bacterial species by month (female and men) for 2023.

The analysis of fungal infections was one of the study's most interesting topics, both because of the negative effects they have on human health and because of the significance they have for the patient's aesthetic aspect. Furthermore, even while the numbers of yeast species found in the lake or Ionian Sea waters are smaller, those with a higher pathogenic potential present a greater risk of infection (Heidi Christa Steffen et al., 2023). These individuals may thus be at risk of developing yeast infections as a result of direct exposure to contaminated waters; this could be harmful for those without access to treatment and is made worse by the worldwide spread of antifungal resistance (Amir Arastehfar et al., 2021). Even in other investigations, the dangers posed by fungal pathogens in water and, consequently, in humans are yet unknown (Weiskerger1 & Brandão2 3 2020). Table 3 displays the outcomes for the years 2022 and 2023.

Table 3. Total amount of Candida by age group - female and male, for the year 2022 - 2023

Candida albicans: DHP and Intermedica (Females and Males) Year: 2022 - 2023									
Age group	Total positive	Ear Material	Faeces	Mouth Material	Nail Material	Skin Material	Throat Material	Vaginal discharge	
0 - 15	28	0	14	1	0	4	2	7	
16 - 25	35	0	7	1	1	0	1	25	
26 - 35	41	0	3	4	0	2	0	31	
36 - 45	35	0	8	1	1	0	0	25	
46 - 55	28	1	8	5	0	3	0	11	
56 - 65	56	0	11	20	0	1	0	24	
< 66	64	0	19	23	3	5	0	15	
Total	287	1	70	55	5	15	3	138	

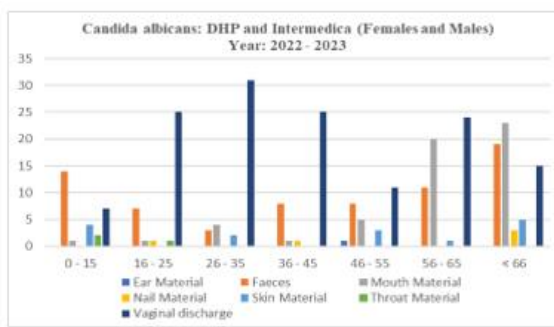
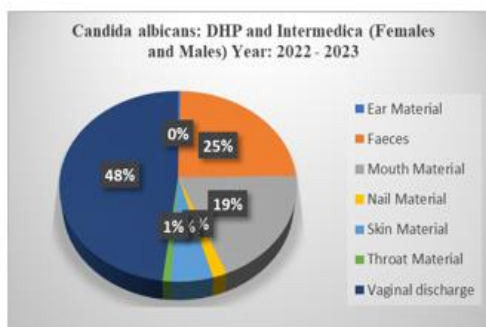


Figure 7 and 8. Dynamics of Candida circulation in various infections by age group (female and male) for 2022-2023.

For the years 2022 and 2023, there were 284 positive patients, with the largest group being those aged 66 and up (63 persons or 22.2%) and the smallest group being those aged 1 to 15 years (27 patients or 9.51%). Analyses obtained from vaginal secretions showed a higher tendency of fungal infections (123 patients, 43.3%), followed by fecal contamination (67 patients, 23.6%).

Fungaemia due to molds continues to be the most prevalent in the youngest and oldest members of the population. Children under 1 year of age had an overall rate of 9.7 per 100,000 population in 2022. This was higher in males than females (11.1 vs. 8.1 per 100,000 population) and considerably higher than for older children. The highest overall rate of fungemia was seen also in persons aged 75 years and over (13.3 per 100,000 population). This is consistent with findings in previous years (UKHSA 2019) and is likely due to greater exposure to risk factors for invasive fungal disease, such as invasive surgical procedures and prolonged use of broad-spectrum antibiotics. Sex differences were more significant in older age groups; in persons aged 75 years and over, there were 12.2 more men (per 100,000 population) in 2022 than women (males 20.3 per 100,000 and females 8.1 per 100,000) (UK Health Security 2022).

In accordance with the study, children and the elderly, as well as people with weakened immune systems, are especially prone to waterborne infections. Water stress is expected to affect three billion people by 2025 as a result of inadequate access to safe drinking water. Water-related diseases and mortality occur in both developed and impoverished countries. Waterborne infections are a global issue, particularly in developing countries. (Godfrey et al., 2023).

According to a World Health Organization (WHO) research, diarrheal illnesses are thought to be responsible for almost 25% of the environmental burden worldwide. Exposure to contaminated drinking water is the primary cause of this condition, but there are other equally significant contributing factors, such as poor sanitation and hygiene habits, which greatly aid in the development of gastrointestinal illnesses (Harris et. al., 2017). In order to avoid and control E. coli contamination, it is imperative that local and health institutions step in and efficiently manage surface water sources (Gwimbi et al., 2019).

From the study we also found that some of the factors that may be responsible for this increase in the number of bacterial and fungal infectious diseases in the Saranda region, mainly during the summer season, may be related to the 20-fold increase in the number of residents during the tourist season in the Saranda region. This increase in the number of residents/tourists encourages activities such as fishing, water sports, use of public facilities, increased plastic use, decreased personal cleanliness, etc. On the other hand, there is a lack of effective and complete supervision by the local government. Untreated wastewater discharge into streams, rivers, lakes, and the Ionian Sea is one example of an element that has been a constant issue over time and undoubtedly affects the water's microbiological quality and biota (marine flora and fauna). Public health and other areas are significantly impacted by this unfavorable circumstance.

Previous research in the Butrint Lake area concluded that during the month of November, the microbial load with F. coliform in the three defined stations was higher (110,000 bacteria/100 ml of water) than the EU's values (the allowed value is 2,000 bacteria/100 ml of water), owing to human activities such as fishing, boating, discharge of untreated sewage or other waste from surrounding residential areas, rains, and so on. The lowest F. coliform levels were recorded in March and April (Çullaj B.¹ et al., 2022). The most affected period, mainly in terms of water supply, is the year 2022, which also coincides with the post-COVID-19 period. Due to the prolonged isolation, tourist regions, including the Saranda region, suffered overcrowding, dramatically increasing the prevalence of fungal and bacterial diseases. Without surface water monitoring, water quality, not to mention the presence of pathogens (which have an impact on public health), may not have been a priority during the COVID-19 pandemic. However, with time it was proven that the management of water systems and their quality is important not to be neglected, as it can increase the risk of waterborne infections (De Giglio Osvalda^{a*} et al., 2020; ESGLI 2020) and increase the number of patients with gastrointestinal disorders. An additional concern is antibiotic resistance, which during the COVID-19 pandemic has been used in many cases in our country, without criteria and not necessarily in the fight against viral diseases, making bacteria “superbugs” (Radisic Vera^{1 2} et al., 2024).

To reduce these risk factors and protect public health, it is critical to implement improved environmental protection measures, improve water supply and sewage infrastructure, promote useful hygiene practices, and use advanced water treatment technologies before discharge into the sea, as well as the Ionian Sea, which runs through the Saranda region. Furthermore, constant monitoring of surface waters and the execution of regulations in accordance with EU directives and Albanian state approvals remain top priorities.

CONCLUSIONS

- Continuous microbiological monitoring of surface waters should be standard practice in Saranda, its surrounding area, and worldwide.
- To promote premium tourism and protect public health, particular care must be taken to ensure the excellent quality of surface and drinking waters.
- More attention should be devoted to the treatment of waters before they are discharged into recreational waterways, particularly the quality of human and animal fecal microorganisms that cause infectious diseases.
- According to the UNEP/WHO and EU norms for bathing (recreational) waters, as well as those approved by our country, compliance is necessary as a condition for admittance into the EU. Our research reveals that we still have issues with the microbiological quality of surface waters.

Special attention. Special attention should be devoted to the collaboration and information of these areas' communities, as well as local and central authorities, in order to implement the laws and directives in force in our country.

Conflict of Interest. The authors declare that they have no conflict of interest.

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