



## MICROBIOLOGICAL ANALYSIS AND ASSESSMENT OF COASTAL BATHING WATERS IN REGION VARNA

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### ABSTRACT

Water contaminated by human and animal excreta may contain a range of pathogenic microorganisms such as viruses, bacteria and protozoa. During the bathing season, water samples are taken and analyzed for *Escherichia coli* and intestinal enterococci .

**The aim** of these study is to assess the quality of bathing waters along Black Sea Coast in Varna Region from 2012 to 2016.

**Materials and Methods:** The information about microbiological monitoring of coastal bathing waters in Region Varna is received from Regional Health Inspection – Varna.

**Results and discussion:** From May 2012 to August 2016, 1117 water samples were collected and analyzed in the Laboratory of Sanitary Microbiology of Regional Health Inspection – Varna. In the region of Varna, there is a tendency to increase the number of bathing areas with excellent water quality.

In Avren Municipality, bathing water was classified as good and excellent.

In Shkorpilovtsi – Tsentralen plazh, the bathing water was excellent quality. In Byala Municipality there was a deterioration in the quality of the seawater.

During 2012-2016 two of these 17 sites – Riviera, located in resort Golden Sands and St. Elias located in St. St. Konstantin and Elena had excellent bathing water quality.

The water indicators of Ofitserski plazh- Varna and Tsentralen plazh, Zlatni pyasatsi - PSVO were poor, while the indicators of Varna -Yuzhen plazh were satisfying or good.

**Conclusion:** According to the European Environment Agency, the development and improvement of community water supply and collecting system will have a positive effect on the quality of bathing water.

**Keywords:** Black Sea Coast, water-born infections, bathing water quality, most probable number

### BACKGROUND

Water contaminated by human and animal excreta may contain a range of pathogenic microorganisms such as viruses, bacteria and protozoa. When water is used for swimming and other high-contact activities these organisms may cause infections in the respiratory and gastrointestinal tract. In most cases, the health effects from exposure to contaminated water are minor and short-term but there is a potential risk for more serious diseases such as hepatitis A, salmonellosis and cryptosporidiosis (1). It is difficult and impractical to measure the levels of all possible pathogens and therefore indicator microorganisms which indirectly tell us the levels of pathogens are commonly used. During the bathing season, water samples are taken and analyzed for *Escherichia coli* and intestinal enterococci which are indicators for the presence of contamination with sewage, livestock waste, bird faces etc.

**The aim** of these study is to assess the quality of bathing waters along Black Sea Coast in Varna Region from 2012 to 2016.

### MATERIALS AND METHODS

The information about microbiological monitoring of coastal bathing waters in Region Varna is received from Regional Health Inspection – Varna.

In Varna Region, there are four municipalities along the Black Sea coast – Varna, Avren. Dolni Chiflik, Byala and there are 23 bathing areas with one point for sampling included in the monitoring program (Table 1).

**Table1.** Bathing areas in Region Varna

| Municipality | Bathing area                               | Beach length             | Number of visitors   |
|--------------|--|--------------------------|----------------------|
| Varna        | Zlatni pyasatsi - PSOV                     | 650 m                    | 100-300 people       |
|              | Zlatni pyasatsi – Morsko kasino            | 2500 m                   | 1 000 – 1 200 people |
|              | Zlatni pyasatsi - Riviera                  | 700 m                    | 800 – 1 000 people   |
|              | Kabakum – Tsentralen plazh                 | 1400 m                   | 1 000- 1 200 people  |
|              | Slanchev den – hotel Marina                | 1400 m                   | 1 000 – 1 200 people |
|              | Sv. Konstantin i Elena – Golyam plazh      | 400 m                    | 150-300 people       |
|              | Sv. Konstantin I Elena Do Mineralen baseyn | 100 m                    | 15-20 people         |
|              | Sv. Konstantin i Elena plazh Malka Riviera | 200 m                    | 50-150 people        |
|              | Sv. Konstantin i Elena Sent Elias          | 350 m                    | 400 – 500 people     |
|              | Varna - Briz 3 Bunite                      | 2 200 m                  | 1 000 – 1 200 people |
|              | Varna- Ofitserski plazh                    | 750 m                    | 500 – 600 people     |
|              | Varna – Tsentralen plazh                   | 1 000 m                  | 500 – 600 people     |
|              | Varna – Yuzhen plazh                       | 400 m                    | 300 – 400 people     |
|              | Varna Asparuhovo Tsentralen                | 1 200 m                  | 500 – 1 000 people   |
|              | Fichoza – Hizha Veteran                    | 1 300 m                  | 150 – 300 people     |
|              | Hizha Chernomorets                         | 1 000 m                  | 50 – 150 people      |
|              | Pasha dere                                 | 1 500 m                  | 50 – 100 people      |
|              | Avren                                      | Kamchia plazh Roomantika | 2 800 m              |
| DolniChiflik | Shuorpilovtsi – Tsentralen plazh           | 2 500 m                  | 400 – 500 people     |
| Byala        | Byala Severen plazh                        | 1 300 m                  | 100 – 300 people     |
|              | Byala Tsentralen plazh                     | 2 700 m                  | 300 – 800 people     |
|              | Byala plazh Chayka                         | 300 m                    | 15 – 20 people       |
|              | Byala Kamping Luna                         | 400 m                    | 150 – 300 people     |

Microbiological monitoring of bathing waters was made following the indicators included in Ordinance No. 5 for the quality management of bathing water (SG, Issue 53/2008) (2). This Ordinance reflects the EU Bathing Water Directive (2006/7/EC) (3).

One pre-season sample (taken shortly before the starting of the bathing season) and two samples per every month of the active touristic season (June, July, August) were collected from each area. Three samples per month were collected only from Varna-Ofitserski plazh, Varna Zentralen plazh, Varna Yuzhen plazh. Water samples were taken from 30 cm below the surface in sterile bottles of 300-500 ml.

For the microbiological measurements were used the micro plate methods for statistical analysis of the taken water samples. The calculation of the most probable number (MPN) was detected with the help of tables and allowed the detection of the MPN within a confidence interval of 95% with a lower and upper limit. The

method was certified after the Bulgarian State Standard BDS EN ISO7899-1 and the BDS EN ISO 93-08-3. For the isolation and enumeration of *Escherichia coli*, the micro-titer technique with MUG (4-Methylumbelliferyl- $\beta$ -D-glucuronide) has been used. For the isolation and enumeration of enterococci, the microtiter technique with MUD (4-methylumbelliferyl- $\beta$ -D-glucoside) has been used.

The units used in the Bathing Water Directive are cfu (colony forming units). The MPN gives the statistically expected number of bacteria in the sample. Under real circumstances, the number of bacteria is higher than the colony forming units because they may adhere together. The unit cfu takes this phenomenon into account. The bathing water quality assessment is based on the data obtained for each bathing season and the three preceding bathing seasons. As result bathing waters are classified as „poor“, „sufficient“, „good“ or „excellent“ by EEA (Table 2).

**Table 2.** Quality of coastal bathing water

| Parameter                           | Excellent quality | Good quality | Sufficient | Reference methods of analysis |
|-------------------------------------|-------------------|--------------|------------|-------------------------------|
| Intestinal enterococci (cfu/100 ml) | 100*              | 200*         | 185**      | ISO 7899-1 or ISO 7899-2      |
| Escherichia coli (cfu/100 ml)       | 250*              | 500*         | 500**      | ISO 9308-3 or ISO 9308-1      |

(\* based on a 95-percentile evaluation (\*\*) based on a 90-percentile evaluation

## RESULTS

From May 2012 to August 2016, 1117 water samples were collected and analyzed in the Laboratory of

Sanitary Microbiology of Regional Health Inspection – Varna. In the region of Varna, for the period 2012-2016, there is a tendency to increase the number of bathing areas with excellent water quality (Table 3).

**Table 3.** Coastal bathing water quality in Varna Region

|      | Total number of samples | Excellent |      | Good |      | Sufficient |     | Poor |     |
|------|-------------------------|-----------|------|------|------|------------|-----|------|-----|
|      |                         | No        | %    | No   | %    | No         | %   | No   | %   |
| 2012 | 23                      | 9         | 39.1 | 13   | 56.5 | 0          | 0   | 1    | 4,3 |
| 2013 | 23                      | 14        | 60.9 | 8    | 34.7 | 0          | 0   | 1    | 4,3 |
| 2014 | 23                      | 17        | 73.9 | 2    | 8,6  | 2          | 8,6 | 2    | 8,6 |
| 2015 | 23                      | 16        | 69.5 | 2    | 8,6  | 3          | 13  | 2    | 8,6 |
| 2016 | 23                      | 13        | 56.5 | 6    | 26   | 3          | 13  | 1    | 4,3 |

In **Avren Municipality** there is only one bathing area. In 2013 bathing water was classified as good and excellent during the remaining years of the surveyed period.

In the **Municipality of Dolen Chiflik** with a sampling point Shkorpilovtsi – Tsentralen plazh the bathing water was of excellent quality during the entire study period (Table 4).

**Table 4.** Classification of bathing waters' quality in Municipality of Avren and in Municipality of Dolni Chiflik

| Bathing area                     | Category of bathing area |                    |           |           |           |
|----------------------------------|--------------------------|--------------------|-----------|-----------|-----------|
|                                  | 2012                     | 2013               | 2014      | 2015      | 2016      |
| Kamchia Plazh Romantika          | Excellent                | Good or Sufficient | Excellent | Excellent | Excellent |
| Shkorpilovtsi - Tsentralen plazh | Excellent                | Excellent          | Excellent | Excellent | Excellent |

In **Byala Municipality** there was a deterioration in the quality of the seawater. During 2016 at three of the four sampling points the water quality was good, and only in the Luna camping, it was excellent (Table 5).

**Table 5** Classification of bathing waters' quality in Byala Municipality

| Bathing area             | Category of bathing area |                    |           |           |           |
|--------------------------|--------------------------|--------------------|-----------|-----------|-----------|
|                          | 2012                     | 2013               | 2014      | 2015      | 2016      |
| Byala - Severen plazh    | Excellent                | Excellent          | Excellent | Excellent | Good      |
| Byala - Tsentralen plazh | Excellent                | Excellent          | Good      | Excellent | Good      |
| Byala - Plazh Chayka     | Excellent                | Good or Sufficient | Excellent | Good      | Good      |
| Byala - Kamping Luna     | Excellent                | Excellent          | Excellent | Excellent | Excellent |

Varna Municipality includes 17 bathing areas (Table 6).

**Table 6.** Classification of bathing waters' quality in Varna Municipality

| Bathing area                               | Category of bathing waters' quality |                    |            |            |            |
|--|-------------------------------------|--------------------|------------|------------|------------|
|  | 2012                                | 2013               | 2014       | 2015       | 2016       |
| Zlatni pyasatsi - PSOV                     | Poor                                | Good or Sufficien  | Poor       | Sufficient | Good       |
| Zlatni pyasatsi - Morsko kazino            | Good or Sufficient                  | Excellent          | Excellent  | Excellent  | Excellent  |
| Zlatni pyasazi - Riviera                   | Excellent                           | Excellent          | Excellent  | Excellent  | Excellent  |
| Kabakum Tsentralen                         | Good or Sufficient                  | Excellent          | Excellent  | Good       | Good       |
| Slanchev den hotel Marina                  | Good or Sufficient                  | Excellent          | Excellent  | Excellent  | Excellent  |
| Sv. Konstantin i Elena - Golyam plazh      | Good or Sufficient                  | Good or Sufficient | Excellent  | Excellent  | Excellent  |
| Sv. Konstantin i Elena Do Mineralem baseyn | Excellent                           | Good or Sufficient | Excellent  | Excellent  | Excellent  |
| Sv. Konstantin i Elena Plazh Malka Riviera | Good or Sufficient                  | Excellent          | Excellent  | Excellent  | Excellent  |
| Sv. Konstantin ii Elena - Sent Elias       | Excellent                           | Excellent          | Excellent  | Excellent  | Excellent  |
| Varna - Briz 3 Bunite                      | Good or Sufficient                  | Excellent          | Excellent  | Excellent  | Excellent  |
| Varna Ofitserski plazh                     | Good or Sufficient                  | Poor               | Poor       | Poor       | Poor       |
| Varna Tsentralen plazh                     | Good or Sufficient                  | Excellent          | Sufficien  | Poor       | Sufficien  |
| Varna Yuzhen plazh                         | Good or Sufficient                  | Excellent          | Sufficient | Sufficient | Sufficient |
| Varna Asparuhovo - Tsentralen              | Good or Sufficient                  | Good or Sufficient | Good       | Sufficient | Sufficient |
| Fichoza - Hizha Veteran                    | Good or Sufficient                  | Good or Sufficient | Excellent  | Excellent  | Excellent  |
| Hizha Chernomorets                         | Good or Sufficient                  | Excellent          | Excellent  | Excellent  | Excellent  |
| Pasha Dere                                 | Good or Sufficient                  | Good or Sufficient | Excellent  | Excellent  | Excellent  |

During 2012-2016 two of these 17 sites – Riviera, located in the resort and St Elias, located in resort Golden Sands and St. Elias located in St. St. Konstantin and Elena had excellent bathing water quality.

The water indicators of the Bathing areas Varna – Ofitserski plazh were poor, while the indicators of Varna Tsentralen plazh, Zlatni pyasat – PSVO were poor, while the indicators of Varna -Yuzhen plazh were satisfying or good.

These results are in close relation with the fact that the “Shokura”, which flows through the territory of Varna, is highly contaminated and contains a high level of bacteria. As a result of the microbiological monitoring data during the last four years, Regional Health Inspection has taken administrative measures by issuing prescriptions

and orders to ban bathing in these areas.

### CONCLUSION

In Region Varna, four (Zlatni pyasazi – Riviera, Sv. Konstantin i Elena – Sent Elias, Byala –Kamping Luna, Shkorpilovtsi – Tsentralen plazh) out of 23 coastal sites monitored by Regional Health Inspection were graded as „excellent“ and only two (Varna Oficerski plazh and Varna Tsentralen plazh) were graded as „poor“ .

According to the European Environment Agency, the building of a new or expanding the existing waste water treatment plants, the development and improvement of community water supply and collecting system will have a positive effect on the quality of bathing water.

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*Please cite this article as:* Tsankova G, Ivanova E, Konstantinov R, Todorova T, Ermenlieva N. Microbiological analysis and assessment of coastal bathing waters in Region Varna. *J of IMAB*. 2018 Oct-Dec;24(4):2276-2280. DOI: <https://doi.org/10.5272/jimab.2018244.2276>

Received: 20/06/2018; Published online: 12/12/2018



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