

## Prevalence of intestinal parasitic infections among the Bulgarian population over a three year period (2015 – 2017)

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### Summary

The aim of the present study is to perform a retrospective analysis of the prevalence of intestinal parasitic infections among the Bulgarian population over the period 2015 – 2017. The study involved all Bulgarians and foreign nationals residing in the country who had been tested for intestinal protozoa and helminths. A total of 23,785 infections have been revealed, of which 17,712 (74.47 %) were helminth and 6,073 (25.53 %) protozoan invasions. Enterobiasis was found to be the most prevalent among patients infected with intestinal helminths (81.75 %), while giardiasis (62.05 %) was the most common among those diagnosed with protozoan infections. In spite of improved living conditions and increasing public health awareness, parasitic diseases in general, and intestinal parasitic infections in particular, still represent a significant part of the overall morbidity in Bulgaria, thus posing a major issue for the public health care system.

**Keywords:** protozoa; helminths; prevalence; intestinal parasitic infections

### Introduction

Parasitic diseases caused by intestinal protozoa and helminths are among the most common illnesses and one of the major causes of increased morbidity and mortality among people in developing countries (Speich *et al.*, 2016). It is generally acknowledged that parasitic diseases are the most common among children under the age of five as they are more vulnerable to soil-transmitted helminthic infections than adults. Nutritional disorders caused by the parasites may lead to iron deficiency anemia, malnutrition and they may have a negative impact on growth and cognitive development of a child (Bethony *et al.*, 2006; Pullan *et al.*, 2011). Despite all the medical and pharmaceutical advance as well as progress in sanitary engineering, intestinal parasitic infections remain the most prevalent in the world, especially in developing countries

struggling with water scarcity, poor hygiene and lack of adequate health care services. Furthermore, it is difficult to control intestinal parasitoses in these regions due to the high cost of infrastructure improvements and lack of educational projects offered to the population (Speich *et al.*, 2016; Ostan *et al.*, 2007; Mehraj *et al.*, 2008). Water is essential to life, but it is also an important vehicle for pathogen dissemination, and many invasive helminth eggs and larvae, and protozoan cysts are distributed via water in the environment. Protozoa such as *Giardia lamblia* and *Cryptosporidium* spp. are recognized as important waterborne pathogens, causing in some cases severe gastrointestinal disease (Baldursson & Karanis, 2011; Kumar *et al.*, 2014). It has been well documented that the conventional treatment of drinking and waste water is not always sufficient for a complete destruction of protozoan oocysts and helminth eggs (Betancourt *et al.*, 2004; Savioli *et al.*, 2006;

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Hatam-Nahavandi *et al.*, 2015). Incorrect landfilling of human and animal feces is also identified as a possible source of contamination of water sources (Smith *et al.*, 2007) and recreational waters such as swimming pools, water parks and lakes (Savioli *et al.*, 2006). Sometimes sewage overflows also contribute to pollution of surface water and farmland, which leads to the possibility of potential human infections. Food contamination can also occur during food processing, directly (through contaminated equipment or washing water) or indirectly (through contaminated irrigation water) (Dawson, 2005).

Cases of intestinal parasitoses in humans, both autochthonous and imported from other endemic regions of the world, are reported annually in Bulgaria. The aim of this study was to perform a retrospective analysis of the intestinal parasitic infections prevalence in the Bulgarian population for the period 2015 – 2017.

## Materials and Methods

### Examined groups

The study involved all persons, Bulgarians as well as foreign citizens residing in the country, tested for intestinal protozoa and helminths from January 2015 to December 2017. The patients were tested in the Independent Medical Diagnostic Laboratories (IMDL), Parasitological Laboratories at the Regional Health Inspectorates (RHI) and University Hospitals, and at the National Reference Laboratory for Diagnosis of Parasitic Diseases (NRL) at the National Centre of Infectious and Parasitic Diseases (NCIPD).

### Methods for parasitological diagnosis

Fecal samples were investigated for intestinal protozoans and helminths using various methods such as: microscopic examination of direct wet smear, staining with Lugol's iodine, enrichment

helmintho-ovoscopic methods (sedimentation, flotation, formalin-ether concentration method), helmintho-larvoscopy by the methods of Berman and Harada-Mori, a perianal tape test for detection of *Enterobius vermicularis* eggs, staining, culture and rapid immunochromatographic methods for intestinal protozoa.

### Statistical methods

It was used descriptive statistics. The mean, standard deviation and confidence interval of the mean have been calculated in the study.

## Ethical Approval and/or Informed Consent

For the purposes of the present study no informed consent was required from the study participants.

## Results

### Soil-transmitted helminth infections

Of this group two nematode infections i.e., ascariasis and trichuriasis have local transmission in Bulgaria and cases are recorded on the territory of the whole country. Table 1 shows the data on the number of persons tested and diagnosed with ascariasis or trichuriasis.

### Community-acquired parasitic diseases

This group includes three intestinal parasitic diseases: enterobiasis, giardiasis and hymenolepiasis. During the study period a large group of individuals (children, adolescents and adults) was screened for community-acquired parasitic diseases; the tests were performed for prophylactic, epidemiological or clinical indications. The data are presented in Table 2.

Table 1. Distribution of the cases of ascariasis and trichuriasis for the period 2015 – 2017.

Year	Number of persons examined for ascariasis	Number positive	Prevalence (%)	Number of persons examined for trichuriasis	Number positive	Prevalence (%)
2015	637 543	805	0.13	623 288	90	0.01
2016	499 729	678	0.14	493 063	71	0.01
2017	576 159	706	0.12	576 159	110	0.02
<b>Total</b>	<b>1 713 431</b>	<b>2 189</b>		<b>1 692 510</b>	<b>271</b>	
<b>Mean ± Standard deviation</b>	<b>571144 ± 69044</b>	<b>729.7 ± 66.73</b>	<b>0.13 ± 0.01</b>	<b>564170 ± 65935</b>	<b>90.33 ± 19.50</b>	<b>0.01333 ± 0.005774</b>
<b>Lower limit of the 95% confidence interval of the mean</b>	<b>399630</b>	<b>563.9</b>	<b>0.1052</b>	<b>400379</b>	<b>41.89</b>	<b>-0.001009</b>
<b>Upper limit of the 95% confidence interval of the mean</b>	<b>742657</b>	<b>895.4</b>	<b>0.1548</b>	<b>727961</b>	<b>138.8</b>	<b>0.02768</b>

Table 2. Distribution of the cases of enterobiasis, giardiasis and hymenolepiasis for 2015 – 2017.

Year	Number of persons examined for enterobiasis	Number positive / prevalence (%)	Number of persons examined for giardiasis	Number positive / prevalence (%)	Number of persons examined for hymenolepiasis	Number positive / prevalence (%)
2015	479149	4604 / 0.96	481197	1245 / 0.26	388364	126 / 0.03
2016	388971	4403 / 1.13	471537	1367 / 0.29	363359	474 / 0.13
2017	451466	5472 / 1.21	438379	1156 / 0.26	327567	120 / 0.04
Total	1319586	14479/1.10	1391113	3768 / 0.27	1079290	720 / 0.07
Mean ± Standard deviation	439862 ± 46195	4826 ± 568.1	463704 ± 22458	1256 ± 105.9	359763 ± 30558	240.0 ± 202.7
Lower limit of the 95% confidence interval of the mean	325107	3415	407916	992.9	283854	-263.5
Upper limit of the 95% confidence interval of the mean	554617	6238	519493	1519	435672	743.5

#### Taeniasis

A total of 53 individuals were diagnosed with taeniosis caused by beef tapeworm (n = 18 for 2015, n = 19 for 2016 and n = 16 for 2017) during the study period, with the mean annual incidence over the period of 0.25 per 100,000 (0.25 / 100,000 in 2015, 0.26 / 100,000 in 2016 and 0.23 / 100,000 in 2017). Infections with *Taenia solium* have not been revealed.

#### Blastocytosis and cryptosporidiosis

The data on the prevalence of the two intestinal protozoan infections are presented in Table 3.

#### Discussion

Parasitic infections of the gastrointestinal tract have a cosmopolitan distribution. The analysis of our survey data (2015 – 2017) shows that a significant proportion of the country's population were screened for the soil-transmitted helminth infections with local transmission (ascariasis and trichuriasis). A total of 1 713 431 persons were examined for ascariasis; the mean annual prevalence of the disease was 0.13 %. We found that the absolute number of people infected by *Ascaris* remained steady over the present study period, (approx. 730 persons per year). As for the age of the asca-

Table 3. Distribution of blastocytosis and cryptosporidiosis for the period 2015 – 2017.

Year	Number of persons examined for blastocytosis	Number positive	Prevalence (%)	Number of persons examined for cryptosporidiosis	Number positive	Prevalence (%)
2015	345549	660	0.19	352	0	0.00
2016	358697	769	0.21	479	4	0.84
2017	328315	858	0.26	231	14	6.06
Total	1032561	2287		1062	18	
Mean ± Standard deviation	344187 ± 15237	762.3 ± 99.17	0.22 ± 0.04	354 ± 124	6 ± 7.21	2.3 ± 3.28
Lower limit of the 95% confidence interval of the mean	306337	516.0	0.1304	45.94	-11.91	-5.856
Upper limit of the 95% of the confidence interval of the mean	382037	1009	0.3096	662.1	23.91	10.46

riasis patients, our findings are in agreement with previous studies of our and other authors (Harizanov *et al.*, 2013; Dudlova *et al.*, 2016) – 86.8 % (n = 1190) of the infected are children, and the age groups 1 – 4 and 5 – 9 years were most often affected. In most cases the infection is asymptomatic and the diagnosis is made after spontaneous passage of the parasite during defecation or following prophylactic tests. This can be explained by the fact that when the parasite burden is low, infection is often asymptomatic, while high-concentration invasions result in acute abdominal pain and ileus from mechanical obstruction of the small intestine, especially in children (Brooker & Bundy, 2014). Clinically prominent and severely progressing forms of ascariasis may be seen in highly endemic countries where the worm burden may be high and ascariasis is often complicated by malabsorption syndrome, growth retardation, cognitive disorders, impaired immune regulation, and increased risk of secondary infections (Lamberton & Jourdan, 2015).

Trichuriasis is one of the most common helminth diseases worldwide (around 800 million infected individuals), with the highest incidence in warm and humid areas (Dori *et al.*, 2011). The highest prevalence rate is recorded in Central Africa, South India and South East Asia (Alum *et al.*, 2010). In Bulgaria, the disease is with local distribution and only a limited number of cases are recorded annually. Over the three-year study period were registered 271 cases of trichuriasis in the country, and the mean annual prevalence was 0.01 %. It should be pointed out that trichuriasis was recorded primarily among persons living in social institutions (e.g. for children deprived of parental care and adults with mental disabilities), which is in line with our previous findings (Harizanov *et al.*, 2013; Rainova *et al.*, 2018). As regards the age structure of the infected, the prevalence of trichuriasis was higher in the age group over 20 years, 89.3 % (n = 242), and significantly lower among children and adolescents 10.7 % (n = 29). This can be explained by the characteristics of patients staying in mental health facilities and the difficulties in maintaining good hygiene in such institutions, as well as the fact that the number of children's homes or similar institutions has significantly decreased in recent years. However, it needs to be stressed that some of the social care establishments are active foci of soil transmitted helminth infections and greater efforts by the public health authorities are needed with regard to control measures related to diagnosis, timely treatment, environmental remediation. The spread of soil transmitted helminth infections, and ascariasis and trichuriasis in particular, is directly proportional to the population density in the region, education level, health protection measures for wastewater management, use of fertilizers, personal hygiene, available health care and socio-economic country status (Das, 2014). In this regard, the WHO Regional Office for Europe developed a strategy entitled "Framework Program for the Control and Prevention of Soil Transmitted Helminth Infections in the WHO European Region, 2016 – 2020" aiming at reducing the incidence of these parasitic diseases to an extent that they will no longer pose a problem for the public health-

care (WHO, 2016).

The community acquired parasitic diseases are of particular health importance in Bulgaria, because they most often affect children in organized facilities. Of these, enterobiasis continue to be the most common community acquired parasitic infection as its prevalence remains high. During the period of our study 14,479 cases of enterobiasis were recorded, of which 7,922 (54.7 %) in children attending organized children's institutions. In this respect our data are similar to the data in available literature. Enterobiasis is a common disease occurring globally, including in countries in temperate zones. It most often affects children. The prevalence among the pediatric populations in different regions of the world varies from 4 to 28 % (Dori *et al.*, 2011). The average prevalence among the subjects within the study period was 1.10 %, while the average prevalence in the general pediatric population in the country was found to be 1.59 %; however, it should be taken into consideration that the study group involved pre-school children attending child care institutions where annual parasitological testing is obligatory. The second most common of the community acquired parasitic diseases in our study was giardiasis with 3,768 reported cases. *G. intestinalis* is the most commonly detected intestinal parasite in the world (Choy *et al.*, 2014). In developing countries, the prevalence is 20 – 40 %, and infection mainly affects the pediatric population (Vandenberg *et al.*, 2006). In developed countries, the prevalence is 2 to 5 %. In the European continent, giardiasis is the most prevalent in Eastern Europe and Turkey (Alum *et al.*, 2010). Although the prevalence of giardiasis in Bulgaria shows a downward trend (Table 2), it still remains a major public health issue.

Hymenolepiasis is a zoonotic disease caused by the *Hymenolepis nana* (dwarf tapeworm) and *H. diminuta* (rat tapeworm). The disease is endemic in Asia, Southern and Eastern Europe, Central and South America and Africa. Epidemiological studies have shown that *H. nana* is more commonly reported as a cause of human disease than *H. diminuta*. More than 175 million human cases of hymenolepiasis caused by *H. nana* have been reported worldwide and in contrast, only a few hundred people have been described as infected with *H. diminuta*. In general, human cases of hymenolepiasis occur without symptoms. However, in some cases, mild clinical manifestations may be observed, mainly diarrhea, abdominal pain, anorexia and other nonspecific gastrointestinal symptoms (Yang *et al.*, 2017). Hymenolepiasis is a community acquired parasitic disease, rarely recorded in Bulgaria (Rainova *et al.*, 2018). Over the three-year study period a total of 720 cases were registered (mean prevalence 0.07 %).

As regards taeniasis, cases caused by beef tapeworm have been sporadically recorded in the country, they are mainly seen in areas with livestock production. The causes of the disease are mainly a lack of awareness of the disease, slaughtering farm animals at home without the proper veterinary supervision. No cases of pork tapeworm infection were recorded during the study period and we were unable to access the official data on the number of cases of cysticercosis in swine.

Protozoa infections of the gastrointestinal tract are recorded worldwide. The most common outbreaks caused by protozoa are generally associated with *Giardia intestinalis* and *Cryptosporidium parvum*, respectively 40.6 % and 50.8 % (Dudlova *et al.*, 2016). In contrast to the literature data, epidemic outbreaks of *G. intestinalis* or *C. parvum* infections in humans have not been recorded in Bulgaria as yet. Although tests for giardiasis are routinely conducted in all diagnostic parasitology laboratories, it is not the case with the diagnosis of cryptosporidiosis. The tests to diagnose that particular protozoan infection (microscopy of stained slides and rapid immunochromatographic tests) are performed in a relatively small number of diagnostic parasitology laboratories. During the study period, a total of 1062 individuals were examined for cryptosporidiosis, of whom 18 (1.69 %) proved to be positive. Although there is evidence for the presence of *C. parvum* in some water sources in the country (Karanis *et al.*, 2006), the control measures during epidemic outbreaks of diarrheal syndrome primarily focus on bacterial pathogens rather than protozoa.

Cases of *Blastocystis* spp. infections are often diagnosed in developed countries. Its role in the etiology of gastrointestinal symptoms remains unclear. According to some authors, it is a conditionally pathogenic protozoa (Scanlan *et al.*, 2014). According to others, clinical symptoms associated with the presence of *Blastocystis* spp. include nausea, loss of appetite, abdominal pain or chronic diarrhea, often associated with chronic gastrointestinal disease of unknown etiology and irritable bowel syndrome (Yakoob *et al.*, 2010; Fletcher *et al.*, 2014). Studies conducted in Africa showed that *B. hominis* can be a major cause of diarrhea where poor adherence to personal and household hygiene has been described (Graczyk *et al.*, 2005). In our study, the mean prevalence of the infection was 0.22 % in all age groups. Regarding clinical manifestations, there are cases of asymptomatic infections, and when symptoms are present, they are no different from those described in the literature.

The extent of the damage caused by intestinal parasites depends on: (a) the type of the parasite; (b) the parasitic load and clinical course of the disease; (c) the nature of the interactions between the parasitic species and the presence of concomitant infections; (d) the nutritional and immunological status of the population; and e) socio-economic factors. All of the above factors may additionally be affected by seasonal and climatic conditions. It is usually difficult to measure the suffering caused by infectious diseases, and in the case of intestinal parasitic infections, this is even more difficult, as many of the cases are asymptomatic and therefore remain undetected (WHO, 1987). In Europe, intestinal protozoan and helminth infections predominantly spread in Southeast Europe and Turkey where the living conditions are poorer and the socioeconomic status is lower (Hotez & Gurwith, 2011). Over 165 million people (more than 20 % of the European population) live below the poverty line and about 2 % of the European population lives in absolute poverty. This has a significant impact on the incidence and prevalence of parasitic diseases (Stuckler *et al.*, 2009).

Some population groups require particular attention because they are more vulnerable and susceptible to infections and parasitic diseases. One of these is the Roma population, which comprises between 7 and 9 million people living in Central and Eastern Europe. The largest numbers of the Roma people in Europe reside in Romania, Bulgaria, North Macedonia and Slovakia, where they account for over 8 % of the population (Rechel *et al.*, 2009). Of these, 70 % to 80 %, mainly in Bulgaria and Romania, live in poverty, have poor housing conditions, poor hygiene habits and often suffer from malnutrition. Their susceptibility to intestinal parasitic diseases, bacterial and viral infections is very high (Rechel *et al.*, 2009). Other population risk groups in Europe include immigrants, especially migrants from Africa, who often suffer from the so-called “neglected tropical diseases”, as well as the children deprived of parental care living in social institutions (Norman *et al.*, 2010).

## Conclusions

In Bulgaria, the existing regulations for surveillance and control of parasitic diseases provide for relatively high detection rates of parasitic infections. Many of the infected individuals are asymptomatic hosts of parasites. High detection rates can be attributed to annual prophylactic parasitological screening of children (attending children’s establishments/ institutions), adults (working in the food industry, retail outlets, catering establishments, etc.) and migrants. This allows timely treatment of the infected persons who might potentially become the source of infection for other individuals.

## Conflicts of interest

Authors declare no conflict of interest.

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