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The most important parasites in Serbia involving the foodborne route of transmission

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Abstract. Food can be an important route for transmission of parasites to humans. Compared to other foodborne pathogens in Serbia, foodborne (or potentially foodborne) parasites do not get the attention they undoubtedly deserve. The aim of this article is to give an overview of the most important parasitic pathogens that can be transmitted by food, and that cause disease in humans: Echinococcus, Trichinella, Taenia solium and Toxoplasma gondii. For each of these pathogens, the severity of human diseases they cause, incidence, mortality and case fatality rate among humans in Serbia as well as their prevalence in animal species in Serbia are described. Some of the described foodborne parasites can induce severe disease symptoms in humans associated with high case fatality rates, while others can cause massive outbreaks. All of the aforementioned parasites occur throughout Serbia and cause both severe public health problems and substantial economic losses in livestock production. In conclusion, the control measures of foodborne parasites certainly need to include education of farmers and improvement of veterinary sanitary measures in animal farming and animal waste control.

1. Introduction

Within the system of public health control, foodborne parasites do not attract the same level of attention as the bacterial and viral hazards. However, parasites can cause severe clinical symptoms, can have a prolonged disease course and sometimes have fatal outcomes. The primary sources of food contamination are animals and/or humans. Parasites do not replicate in food; however, during food processing, accidental contamination of large amounts of safe, parasite-free food can occur. This situation is commonly seen with Trichinella. Mixing of meat from one Trichinella-infected pig with meat that originates from healthy animals can result in several tens of kilograms of contaminated products, which can cause massive epidemics affecting hundreds of diseased individuals [1]. The transmission of parasites by food is commonly associated with faecal contamination and poor, inadequate hygiene. Although the prevalence of foodborne parasitic diseases remains unreported, it is considered that the global annual prevalence in humans of parasitic trematodes is 56.2 million disease cases of which 7.8 million manifest severe clinical sequelae, with a total of 7,158 fatal outcomes [2].

The complex epidemiology and life cycles of parasites play central roles in the identification, prevention and control of risks associated with foodborne parasitic diseases. Monitoring parasitic diseases is further complicated by their (often) prolonged incubation periods, subclinical course of infections and diagnostic failures in chronic sequelae [3].
The Food and Agriculture Organization of the United Nations (FAO) and World Health Organization (WHO) established a joint international expert group that reported on worldwide foodborne parasite hazards in 2014 [4]. In this report, 24 parasites important for food safety were highlighted, including (ordered by their importance): 1. *Taenia solium*, 2. *Echinococcus granulosus*, 3. *Echinococcus multilocularis*, 4. *Toxoplasma gondii*, 5. *Cryptosporidium* spp. Currently, within the framework of COST Action FA1408, “A European Network for Foodborne Parasites (Euro-FBP)”, 25 parasites are ranked at pan-European and regional level.

The aim of this study is to give an overview of the most important foodborne parasitic pathogens which can cause human diseases in Serbia. So far, several tens of foodborne parasites which belong to the groups of protozoa, nematodes, trematodes and cestodes were identified in Serbia. The identified parasites can be transmitted by the meat of pigs, cattle, sheep and fish and/or by food of plant origin. In this article, four foodborne parasites were selected as the most important. Criteria for selection were: severity of diseases and potential fatal outcomes in humans, the mandatory reporting of human and/or animal diseases and availability of relevant data on their prevalence and incidence in animal and human populations in Serbia. The data were obtained from the official web-sites of authorized institutions such as the Institute of Public Health of Serbia, Dr Milan Jovanović Batut (hereafter called Institute Batut) and the Ministry of Agriculture and Environmental Protection, Veterinary Directorate for the period spanning the beginning of 2005 to the end of 2015, if such data were not available from relevant scientific literature.

2. Foodborne parasites

2.1. *Echinococcus*

The genus *Echinococcus* includes six species, and two of them are the most important from the human health point of view – *E. granulosus* which causes cystic echinococcosis and *E. multilocularis* which causes alveolar echinococcosis. To complete their life cycle, *Echinococcus* requires intermediate and definitive hosts. The definitive hosts – carnivores (most commonly dogs) – excrete, via their faeces, either gravid proglottids containing eggs or eggs. These are deposited directly into the environment. Eggs enter the intermediate host by ingestion. The predominant intermediate host species in Serbia are sheep, cattle and pigs as well as humans [5]. Eggs enter the intermediate host by ingestion. Larvae (metacestodes) and infectious elements (proscolex) develop in the bodies of intermediate hosts.

2.1.1. Human echinococcosis in Serbia. Basic criteria for categorising *Echinococcus granulosus* as an important foodborne parasite in Serbia are severity of human disease and case fatality rate.

Human infection can develop after egg ingestion via contaminated water, unwashed fruits and vegetables or via direct contact with dog hair. After ingestion, eggs release oncospheres that pass from the intestines mostly to the liver, where oncospheres develop into cysts. Besides liver (65%), the cysts can also develop in lungs (25%) and, less frequently, in the spleen, heart or kidneys. Infection is associated with development of single or multiple cysts, which range in size from the size of a walnut to the size of a child’s head [6].

The incubation period commonly lasts from 2 to 15 years, and the clinical manifestation of the disease is determined by the size and location of the cyst. The cyst growth rate is usually 1 to 5 cm per year [6]. In Serbia, the incidence of the disease is higher in females (68.9% in childhood) than in males [7]. The infection can remain asymptomatic for a long period of time, which can result in the formation of cysts containing several litres of fluid full of infectious protoscoleces [6].

The disease often takes a chronic course, wherein clinical manifestations include liver enlargement, abdominal pain, and bile duct obstruction associated with jaundice and vomiting. A pulmonary location of cysts is characterized by severe pain in the chest associated with bloody sputum. Cyst rupture results in anaphylactic shock and death of the diseased person [8]. Cysts in the brain or eye, which are common cyst locations in children, produce clinical manifestations quite rapidly [6].
According to official records from the Institute Batut, in the period 2005 to 2016, three persons in Serbia died from echinococcosis. The mortality rate (number of deaths per 100,000 population) was not high, ranging from 0.01 to 0.05; however, the case fatality rate (number of deaths related to number of sick persons with the disease) was extremely high, ranging from 3.13 to 5.88% in hepatic echinococcosis, over 25.00% in *Echinococcus alia non specificata* and as much as 33.33% in pulmonary echinococcosis. According to these data, pulmonary echinococcosis in Serbia has a fatal outcome in one third of the diseased patients.

Throughout the 11-year monitoring period (2005 to 2016), the average incidence of echinococcosis in Serbia was 0.96 cases per 100,000 population (Table 1). The incidence in Vojvodina was higher than in Central Serbia. The highest incidence was recorded in Vojvodina in 2014, reaching 1.26 cases per 100,000 population.

The first diagnosis of *Echinococcus multilocularis* in beaver [9] in Serbia was established in 2015, which is of significant epidemiological importance. This species causes human alveolar echinococcosis, an extremely severe disease with poor prognosis. Intensive lateral asexual multiplication in the human host results in a significant risk for human health – the spread of foreign tissue is aggressive, like a malignant tumour and can progress from the liver to lungs, spleen and kidneys [10]. The presence of alveolar echinococcosis is confirmed in neighbouring countries; thus, the future occurrence of the disease in humans in Serbia is likely.

2.1.2. *Animal echinococcosis in Serbia.* Serbia, as well as other parts of the Balkans and the Mediterranean basin, is considered an endemic region for echinococcosis. According to research conducted in Serbia, the domestic dog is the predominant definitive host for *E. granulosus*, with an infection prevalence in dogs ranging from 15% in Valjevo to 48% in Požarevac [5].

Echinococcosis is a mandatory reportable disease for both humans and all animal species in Serbia. According to data from the Veterinary Directorate, during 2005 to 2016, examination on livestock slaughter lines revealed only 11 echinococcosis foci, with a total of 62 infected pigs. However, these official data do not reflect the true picture of the infection prevalence in animals. Several scientific publications reported the prevalence of echinococcosis in animals in Serbia. According to Debeljak [5], the prevalence of echinococcosis in Serbia ranges from 70.64 to 95.0% in older sheep categories, 5.76 to 7.27% in beef cattle, 56.95 to 94.61% in cattle and 2.41 to 34.8% in pigs.

The high prevalence of echinococcosis in animals is largely due to the lack of knowledge among Serbian livestock farmers and dog owners. Namely, slaughter of sheep and pigs in households for their own needs is mostly performed without veterinary-sanitary examination. The disposal of offals from intermediate host animals (especially liver that contains *Echinococcus* cysts) is inadequate; they often end up as dog feed. Moreover, dog owners often do not practice dehelminthisation and the population of stray dogs is still not under control [5].

| Year | Toxoplasmosis (non specific) | Trichinellosis | Echinococcosis |
|------|-----------------------------|----------------|----------------|
|      |                             |                |                |
|      | *S* | CS | *S* | CS | *S* | CS | *S* | CS | *S* | CS | *S* | CS |
| 2005 | 0.75 | 0.57 | 1.23 | 4.52 | 1.13 | 13.63 | 0.63 | 0.51 | 0.93 |
| 2006 | 0.92 | 0.90 | 0.99 | 2.53 | 1.66 | 4.87 | 0.81 | 0.45 | 0.7 |
| 2007 | 1.18 | 1.18 | 1.11 | 2.38 | 2.21 | 2.83 | 0.34 | 0.33 | 0.35 |
| 2008 | 1.06 | 1.04 | 1.10 | 1.23 | 0.67 | 2.76 | 0.49 | 0.43 | 0.7 |
| 2009 | 0.99 | 1.01 | 0.96 | 1.52 | 1.89 | 0.51 | 0.44 | 0.48 | 0.3 |
| 2010 | 1.04 | 1.08 | 0.91 | 1.52 | 1.89 | 0.51 | 0.38 | 0.24 | 0.76 |
| 2011 | 0.74 | 0.77 | 0.66 | 1.74 | 1.09 | 3.52 | 0.45 | 0.38 | 0.66 |
| 2012 | 0.86 | 0.89 | 0.78 | 0.64 | 0.70 | 0.47 | 0.54 | 0.61 | 0.47 |
| 2013 | 0.77 | 0.74 | 0.83 | 1.32 | 0.49 | 3.57 | 0.57 | 0.46 | 0.83 |
2.2. *Trichinella*

To date, eight species belonging to the genus *Trichinella* and three still unclassified genotypes (T6, T8 and T9) have been identified [11]. The most important species in Serbia are *Trichinella spiralis* and *Trichinella britovi*. *Trichinella* are transmitted by consumption of meat containing infectious larvae, and susceptible animals include all mammal species, reptiles and birds [12].

### 2.2.1. Human trichinosis in Serbia.

Basic criteria for categorising *Trichinella* as an important foodborne parasite in Serbia are the number of affected individuals, parasite distribution over the entire country in both humans and animals and the case fatality rate. Throughout the 11-year monitoring period (2005 to 2016), the average incidence in Serbia was 1.80 cases per 100,000 population (Table 1). The incidence in Vojvodina region was somewhat higher than in Central Serbia (Table 1). The highest incidence was recorded in 2005 in Vojvodina, being 13.63 cases per 100,000 population.

When comparing the incidence of rates for the three parasitoses monitored during 2005 to 2016, the incidence of trichinellosis was higher than that of echinococcosis and toxoplasmosis (Table 1). The average annual incidence of trichinellosis was 1.8 cases per 100,000 population. The highest incidence of trichinellosis (13.63 cases per 100,000 population; 2005) was far higher than that of the other two monitored parasitoses (echinococcosis – 1.26 cases per 100,000 population and toxoplasmosis – 0.81 cases per 100,000 population).

| Year | 2014 | 2015 | Average | SD | Min | Max |
|------|------|------|---------|----|-----|-----|
|      | 1.06 | 1.15 | 0.96    | 0.16 | 0.74 | 1.18 |
|      | 0.99 | 1.17 | 0.94    | 0.19 | 0.57 | 1.18 |
|      | 1.26 | 1.10 | 0.99    | 0.19 | 0.66 | 1.26 |
|      | 1.20 | 1.15 | 1.80    | 1.05 | 0.64 | 4.52 |
|      | 0.95 | 0.55 | 1.20    | 0.61 | 0.49 | 2.21 |
|      | 1.88 | 2.79 | 3.39    | 3.68 | 0.47 | 13.63 |
|      | 0.63 | 0.73 | 0.55    | 0.15 | 0.34 | 0.81 |
|      | 0.58 | 0.62 | 0.46    | 0.12 | 0.24 | 0.62 |
|      | 0.78 | 1.05 | 0.68    | 0.23 | 0.30 | 1.05 |

- a – Republic of Serbia
- b – Central Serbia region
- c – Vojvodina region
- d – Standard deviation

Human trichinellosis develops after ingestion of live *Trichinella* larvae, most commonly *via* the meat or meat products. Traditional smoked pork products are the main source of infection (76%). The occurrence of human trichinellosis in Serbia shows strong seasonality, and most of the cases occur during winter [13].

The disease in humans takes an acute course. The incubation period ranges between one and 33 days. The mean time between onset of symptoms and admission is nine days. Family outbreaks are the most frequent, rather than individual cases or large-scale outbreaks. Fever is the most frequent clinical manifestation (90%), followed by myalgia (80%) and periorbital oedema (76%) [13]. The clinical manifestations of disease are determined by the number of ingested larvae, but also by the immune status of the individual. Infrequently, the disease progresses to a chronic course and manifests as myalgia and fatigue. Complications from trichinellosis include myocarditis, endocarditis, encephalitis, and meningitis, all with an accompanying poor prognosis [14]. Fatal outcomes of trichinellosis occur in third to fifth week of infection, though not very frequently. According to official data, from 2005 to 2016, three fatal outcomes were recorded in Serbia in 2005. The mortality and case fatality rates were not high, being 0.02 to 0.10 and 0.72 to 1.61, respectively. However, the very existence of fatal outcomes in humans emphasizes the importance of this foodborne parasite.
2.2.2. **Animal trichinellosis in Serbia.** Serbia is considered an endemic area for trichinellosis. In Serbia, *Trichinella* has been reported in domestic pigs, horses, wild boars, foxes, jackals, raccoons, wolves, and bears [15, 16]. Domestic pigs are the predominant reservoir of human infection.

Trichinellosis is a mandatory reportable disease for both humans and all animal species in Serbia. According to official data from the Veterinary Directorate, during the monitored period (2005 to 2016), 2,307 trichinellosis foci were reported, and a total of 3,084 infected pigs. According to the literature data, the prevalence of trichinellosis in domestic pigs in Serbia is around 0.02%, but it can reach approximately 0.5% in endemic regions and about 1% in wild boars [17,18].

Endemic persistence of trichinellosis in Serbia is determined by a range of factors, including poor socioeconomic conditions, inadequate education of livestock farmers and food business operators, insufficient veterinary control and improper disposal of dead animals [16].

2.3. **Taenia solium**

Tapeworms *Taenia saginata* and *Taenia solium* are zoonotic parasites and both are present in Serbia. Humans are the definitive host for both *Taenia* species, and cattle and pigs are intermediate hosts for *T. saginata* and *T. solium*, respectively. Tapeworms can cause two diseases—taeniasis and cysticercosis.

Taeniasis is a parasitic disease of the definitive host, humans. The disease is induced by adult tapeworm (either *T. saginata* or *T. solium*) inhabiting the intestines, and is typically associated with mild clinical manifestations. Taeniasis develops in humans after consumption of undercooked meat containing cysts enclosing viable larvae [4]. *T. saginata* poses comparably lower severity of foodborne disease than *T. solium*, as it causes only taeniasis.

Cysticercosis is a parasitic disease of the intermediate hosts, cattle and pigs. In cattle, cysticercosis is caused by ingestion of *T. saginata* eggs and in pigs by ingestion of *T. solium* eggs [4]. Rarely, *T. solium* cysticercosis also occurs in humans, after autoinfection by ingesting eggs excreted from *Taenia* living in their own or somebody else’s intestines. Therefore, the severity of human disease caused by *T. solium* is comparably much higher than that caused by *T. saginata*, as it can cause not only taeniasis but also human cysticercosis. Cysticercosis in humans potentially affects vital organs and has associated severe complications.

2.3.1. **Human cysticercosis in Serbia.** Basic criteria for categorising *Taenia* as an important foodborne parasite in Serbia are the severity of the disease in humans, distribution over the entire country and case fatality rate.

According to the FAO, *T. solium* is ranked as the most important foodborne parasite in the world. *T. solium* infections are endemic in a number of underdeveloped countries in Africa, Asia, and South America and are associated with poverty, poor sanitary and living conditions as well as inadequate health protection [19]. Cysticercosis is considered an endemic disease in Europe. The regions of the Mediterranean basin and Southeastern Europe (including Serbia) are areas with sporadic cases of autochthonous infection. In the European Union, a substantial number of imported cases of the disease was recorded in humans with history of travel or stay in underdeveloped countries [19].

Humans become infected by ingesting eggs of *T. solium* either directly via the faecal-oral route, via contaminated food and/or water, or via autoinfection in individuals with taeniasis (see above). Once eggs are in the human intestines, they release embryos that spread over the entire body to form cysts. In humans, the central nervous system is the primary site of cyst formation; however, cysts can also occur in striated muscles [20].

The symptoms of human cysticercosis are not pathognomonic and are determined by the location, number and size of lesions as well as the immune status of the diseased individual. The most severe form of cysticercosis is neurocysticercosis, which can lead to epileptic seizures and fatal outcomes. In underdeveloped countries, cysticercosis causes severe human diseases, and it is considered the leading cause of acquired epilepsy in developing countries (30%). It is believed that neurocysticercosis is
associated with around 6.3% of reported epilepsy cases in developed countries [19]. The case fatality rate is not high, being <1% [4].

Human cysticercosis is not a mandatory reportable disease in Serbia, and therefore, there are no official data on its incidence among the human population in Serbia. Available data on human cysticercosis in Serbia were obtained from scientific literature. According to Bobić et al. [21], the annual incidence of cysticercosis varies between 0 and 0.29 cases per 100,000 population. During the 1990s, a statistically significant increase in the number of cases was observed. The situation has changed after 2000, and ever since, a statistically significant decrease cases has been recorded. In Serbia, the majority of hospitalized cases (67.2%) were aged 30-59, and the incidence was the same among genders [21]. Less than 9% of cases belonged to professionally endangered categories (e.g. farmers) [21]. According to data from http://global-disease-burden.healthgrove.com the mortality rate in Serbia has decreased, with the following values: 0.0005 deaths per 100,000 population in 2005; 0.0003 deaths per 100,000 population in 2010, and; 0.0002 deaths per 100,000 population in 2013. The majority of deaths associated with cysticercosis were recorded in individuals more than 80 years old.

2.3.2. Animal cysticercosis in Serbia. Animals acquire cysticercosis either from the environment or by direct contact with faeces from infected humans. In undeveloped countries, cysticercosis causes substantial economic losses in pig production. Neurocysticercosis in pigs can lead to seizures similar to epileptic seizure in humans with neurocysticercosis. Pigs manifest tonic muscle contractions followed by sudden diminution in all muscle tone leading to collapse, and they typically walk in circles [22].

Bovine and porcine cysticercosis are mandatory reportable diseases in Serbia and meat inspection is performed to determine the disease on livestock slaughter lines. During 2005 to 2016, according to official data, seven cases of bovine cysticercosis were reported in Serbia. According to the literature data, a low prevalence of bovine cysticercosis is continuously present in the country [23]. According to data from the World Organisation for Animal Health (www.oie.int) from 2005, Serbia reported 65 cases of porcine cysticercosis in 2009 and 4 cases in 2006.

Risk factors for spreading cysticercosis include free access of animals to pastures and risky waters as well as uncontrolled human defecation in the proximity of farms [24]. In developed countries, application of proper sanitation measures, adoption of intensive pig production systems and adequate control on the livestock slaughter line resulted in either complete eradication or control of cysticercosis [25].

Even if the incidence of cysticercosis in Serbia is decreasing, the disease has not yet been fully eradicated. Similarly to the other foodborne parasites, adequate education of livestock farmers and upgrades to veterinary-sanitary measures are the prerequisites to improve the epidemiological situation.

2.4. Toxoplasma gondii

Toxoplasma gondii is a protozoan parasite infecting virtually all warm blooded species, including man and food producing animals. The genus Toxoplasma encompasses only one species, Toxoplasma gondii; however, there are several genotypes (I, II, III). The definitive hosts of Toxoplasma are Felidae family members. Definitive hosts shed oocysts into the environment in their faeces, thus infecting intermediate hosts [26].

2.4.1. Human toxoplasmosis in Serbia. Basic criteria for categorising Toxoplasma as an important foodborne parasite in Serbia are severity of the disease in humans, distribution over the entire country and number of affected individuals.

2. Throughout the 11-year monitoring period (2005 to 2016), the average incidence in Serbia was 0.96 cases per 100,000 population (Table 1). The incidence rate in Vojvodina is somewhat higher than
that in Central Serbia. The highest incidence was recorded in Vojvodina in 2014, being 1.26 cases per 100,000 population.

Human toxoplasmosis has a worldwide distribution with highly variable seroprevalence ranging from 10 to 70%. The three infectious forms of *Toxoplasma* are tachyzoites, bradyzoites and oocysts. Bradyzoites are transmitted by tissues of intermediate hosts, and oocysts by faecally contaminated food and water. An outbreak of toxoplasmosis which was caused by unpasteurized goat milk with confirmed tachyzoite finding was reported by Guy et al. [26]. According to research conducted in Serbia, consumption of undercooked meat (mainly beef) is the main risk factor for the development of toxoplasmosis [27].

The clinical picture of alimentary toxoplasmosis caused by bradyzoites in meat varies according to the degree of meat invasion, cooking method and meal preparation technique as well as immune status of the infected individual and the genotype of *Toxoplasma* [26]; this makes the clinical course of the disease highly variable.

In immunocompetent persons, clinical manifestations are mild, encompassing moderately elevated body temperature, fatigue, throat and muscle pain and headache.

In immunocompromised individuals (patients with AIDS or those undergoing immunosuppressive therapy or treatment), clinical manifestations of toxoplasmosis can be extremely severe, including encephalitis, retinochoroiditis and pneumonitis [26,27]. Toxoplasmic encephalitis is one of the leading causes of deaths of patients with AIDS.

Ocular toxoplasmosis can produce a complicated clinical picture, and it sometimes results in partial or total loss of vision. Even though available literature mostly reports ocular toxoplasmosis occurring in Africa and South America, cases of this disease were also recorded in Serbia.

Toxoplasmic encephalitis is one of the leading causes of deaths of patients with AIDS. Congenital toxoplasmosis is a particularly severe form of toxoplasmosis. The disease is not foodborne, but can occur as the consequence of underlying foodborne infection of the mother. Transplacental infection can lead to abortion or, if the foetus survives, occurrence of hydrocephalus, seizures, retinochoroiditis, spasticity, deafness, and hepatosplenomegaly [26,27]. In some cases, newborns do not manifest disease symptoms at birth; however, later in life, they can manifest symptoms of mental retardation and retinochoroidal lesions. If the infection is acquired at some later stage of pregnancy, the child can remain without symptoms or have only mild complications. Clinical picture is determined by the genotype of *Toxoplasma* [26].

2.4.2. Animal toxoplasmosis in Serbia. Toxoplasmosis in animals occurs worldwide, including in Serbia. Animals can acquire toxoplasmosis either from the environment or by direct exposure to infected cat faeces. Clinical manifestations of the disease in animals have not been recorded. In some countries, sheep and goats are the main source of human infections, whereas predominant reservoirs in other countries are pigs and cattle. In theory, poultry meat could be considered a source of infection; however, there are no records of toxoplasmosis epidemics associated with poultry meat so far [28].

Animal toxoplasmosis is not a mandatory reportable disease in Serbia, but according to the Veterinary Directorate, there were two reported cases of sheep toxoplasmosis in Serbia (one each in Zlatibor and Srem Districts). Seroprevalent animals were reported in 2007 and 2015 including five sheep. Scientific literature reported seroprevalences in domestic animals in Serbia as: 84.5% of sheep, 76.3% of cattle, and 28.9% of pigs being seropositive [27].

Toxoplasmosis shows the worldwide distribution including our country as well. Decrease of toxoplasmosis prevalence in domestic animals can be accomplished primarily by improvement of biosecurity measures on farms. This requires excluding cats as a means of rodent population control on farms.
3. Conclusions
The described foodborne parasites, *Echinococcus*, *Trichinella*, *Taenia solium* and *Toxoplasma gondii*, are endemically present in Serbia. Their distribution and persistence within the domestic animal population is directly associated with inadequate zoohygienic conditions including contamination of irrigation water, usage of manure for fertilization purposes, poor personal hygiene or inadequate food preparation practices. Moreover, the level of education of farmers and pet owners regarding personal hygiene and keeping livestock and/or pets in a healthy and hygienically responsible manner is not adequate.

Improvement of veterinary-sanitary controls for animal farming systems and safer handling and disposal of animal waste from farms and slaughterhouses are prerequisites for enhancing the epidemiological situation in Serbia with respect to parasites.

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