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Contamination of Soil and Vegetation with Developing Forms of Parasites in Sarajevo Canton

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Abstract
The aim of the study was to investigate parasitic contamination of soil and vegetation on different locations in the Sarajevo Canton and to propose the rehabilitation measures. Among 55 locations sampled in the Canton Sarajevo in 2015, 33 (66%) were positive. In total, 220 soil samples and 80 plant samples were tested, and 59 (26.82%) and 12 (15%) were positive, respectively. Five different parasite-developing stages were determined. The highest level of contamination was detected in the parks (77.77%) and playgrounds (75%). Among 33 positive locations (60% of examined locations), taeniid eggs were detected in four (12.12%), *Toxocara canis* eggs in 32 (96.97%), *Trichuris* spp. eggs in nine (27.27%) and ancylostomatid eggs in six locations (18.18%), while nematode larvae were identified in 14 locations (42.42%). Out of 71 soil and plants positive samples, taeniid eggs were identified in four (5.63%) and *Toxocara canis* eggs in 50 samples (70.42%). *Trichuris* spp. eggs were found in nine (12.67%), ancylostomatid eggs in six (8.45%) and nematode larvae in 17 samples (23.94%). Concerning the public health aspect, it is crucial to reduce parasitic contamination by implementing adequate preventive measures in line with the legislation. Involvement of all concerned particularly pet owners (parents and children), veterinarians, physicians, and environmentalists, should be strongly encouraged with major emphasis on permanent education.

Keywords
Sarajevo Canton — parasites — contamination — soil — vegetation

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Introduction

More than 2 billion people worldwide are infected with soil-transmitted helminths (31, 36). According to CDC (2015), soil-transmitted helminths represent an important public health issue because a huge part of human population was infected at least once or more during the life. Globally, it is estimated that approximately 807 to 1.121 million of people were infected with *Ascaris lumbricoides*; 604 to 795 million with *Trichuris trichiura* and 576 to 740 million with *Ancylostoma duodenale* and *Necator americanus*.

In addition to common canine and human parasites such as *Echinococcus granulosus*, *Leishmania infantum*, or *Giardia duodenalis*, the developing forms of nematode canine parasites (*Toxocara canis*, *Ancylostoma caninum*, *Uncinaria stenocephala*, *Trichuris vulpis*, and others) also present serious risk to human health. Even though developmental stages do not reach their adult forms, they cause various pathogenic effects in specific organs or tissues after entering human digestive tract as a non-specific carrier or if larvae penetrate the skin (*A. caninum*, *U. stenocephala*). The disease is manifested as "visceral, cutaneous and ocular larva migrans syndrome (VLM, CLM, OLM)".

In general, cats and dogs can host about 300 parasite species (30). In Bosnia and Herzegovina (B&H), cats and dogs can be the hosts to approximately 40 parasite species, half of which are able to infect humans (12). In the Sarajevo region, parasite species causing larva migrans are most common in dogs, being detected in 43.08% (17), 86.36% (13) and 99.06% (7) of examined dogs. Particularly frequent cause of larva migrans syndrome is *T. canis*, which females are able to produce up to 200.000 eggs per day (19). Prevalence of *T. canis* in B&H was estimated to range from 29.87% to 53.89% (19)

Humans, especially children, can be infected by ingesting different parasite developmental stages. This involves food-borne and water-borne infection routes of the parasite stages, where inadequate hand washing after contact with animals and contaminated soil and plants play equally or even more important role. Eggs and parasite larvae can be detected in high numbers in soil and on vegetation close to the dog outdoor environment. They can survive for a long time even under unfavorable environmental conditions. The fact that a great proportion of people who suffered from toxocariasis never owned or had a dog contact, leads to the conclusion that contaminated soil or vegetation play a crucial role in epidemiology of the human disease.

Clinical signs of the disease in humans may vary, where large number of cases are inapparent or with unspecific symptoms.

Severe cases are characterized with abdominal pain, hep-

Table 1. Estimated frequencies (%) of soil contamination of public areas by roundworm, hookworm and whipworm eggs on different countries (31)

Country	Site	Frequency (%)		
		Roundworms	Hookworms	Whipworms
Niger	Kaduna	-	9	-
USA	Connecticut	14.4	-	-
Argentina	Buenos Aires	13.2	-	-
	Buenos Aires	1.7	20.5	2.6
Brazil	Fernandopolis	79.4	6.9	-
	Itabuna	-	47.9	-
	Sao Paolo	29.7	-	-
	Guarulhos, Sao Paolo	68.1	64.8	
Chile	Santiago	66.7	-	-
Venezuela	Ciudad Bolivar	-	61.1	-
Japan	Tokushima	63.3	-	-
Thailand	Bangkok	5.7	-	-
Turkey	Ankara	45	-	-
	Erzurum	64.3	-	-
Ireland	Dublin	15	-	-
Spain	Madrid	16.4	3	-
Italy	Milan	7	3	5
	Bari	2.5	1.6	2.5
	Naples	0.7-1.4	2.4	10.1
	Messina	3.6	2.6	1.3
	Alghero	0.5-8.0	4	1.9
Poland	Wroclaw	3.2	4.9	4.9
	Warsaw	26.1	-	-
	Krakov	15.6-19.8	-	-
Czech Republic	Prague	20.4	-	-
Hungary	Eastern and northern areas	24.3-30.1	8.1-13.1	20.4-23.3
Slovak Republic	Bratislava	18.7	-	-

Table 2. Contamination of soil with developing forms of parasites in B&H

Reference	Locations	Positive findings		Identified developing forms of parasites
		Locations (%)	Samples (%)	
Zuko et al. (1998)	Sarajevo Canton	46	-	*Toxocara* spp., *Trichuris* spp.
Omeragić (1999)	Sarajevo Canton	55.38	31.3	*Toxocara canis*, *T. cati*, *Toxascaris leonina*, *Trichuris spp.*, *Capillaria* spp., *Ancylostomatidae*, *Isospora canis*, *I. ohioensis*
Omeragić (2002)	Herzegovina (municipalities Mostar, Konjic, Jablanica)	73.33	40	*Taeniidae*, *Toxocara canis*, *Trichuris* spp., *Ancylostomatidae*
Omeragić et al. (2004)	Municipality of Visoko	51.42	30	*Taeniidae*, *Toxocara canis*, *Trichuris* spp., *Ancylostomatidae*
Omeragić et al. (2006)	Bosnian-Podrinje Canton	42.3	25	*Taeniidae*, *Toxocara canis*, *Trichuris* spp., *Ancylostomatidae*

atomegaly, respiratory disorders, muscle aches, and other symptoms depending on the form of the disease, mainly followed by fever, anemia and eosinophilia. The ocular form of the disease manifests in unilateral or bilateral loss of vision resulting from the tissue invasion and development of granulomas in one or both eyes.

The effect of larva migrans in humans was first recognized by Beaver et al. (1), who identified larvae of *Toxocara* spp. in eosinophilic granuloma in three children during laparotomy. Previously, Wilder (33) also described granulomatous and eosinophilic abscesses in the eyes of some patients with suspected retinoblastoma, and histological sections of the granulomas revealed the presence of nematode larvae, which Nichols (16) identified as the second stage larvae of *T. canis*.

In some areas, geophagy causes human infection by roundworm parasites (9). It was also estimated that 50% of the UK patients with clinical toxocarosis never owned dogs

or came in contact with them, which indicates that soil contamination plays the major role in the parasite transmission and human infection (10, 34).

Intensive research on soil contamination with parasites were carried out in the second half of the last century. In the UK, *Toxocara* spp. were identified in 66% (29) and 24.4% (3) soil samples from the parks in London as well as in 5.2% soil samples from public areas and private gardens (23). Contamination of the streets of Leeds by spp. eggs was estimated at 7% (26).

Contamination of soil samples from the city parks of Philadelphia (USA) with Toxocara spp. eggs was estimated at 10.2% (5), while the contamination was detected in 20.57% (4), 10-32% (27) and 6.66-10% (28) of samples taken from schoolyards and parks in other cities of USA.

Eggs of *T. canis* were found in 1.1% of samples taken in Brisbane (Australia) (2). In soil samples collected from 10 kennels, *T. canis* eggs were identified in 27.77% of the samples, and five out of 10 sampled kennels (6). In Cairo (Egypt), *T. canis* eggs were found in 10% of the soil samples (14).

As for European studies, *Toxocara* spp. egg contamination of the city parks in Milan (Italy) was identified in 2% of all samples (8). Out of 100 soil samples taken from 10 different green areas in Zagreb (Croatia), *Toxocara* spp. eggs were identified in 27%, *Trichuris* spp. eggs in 26%, *Ascaris* spp. in 7%, and eggs of *Capillaria* spp. in 7% of the samples (25). Examination of soil samples from Dublin (Ireland) showed a 27.77% prevalence of *Toxocara* spp. egg, where 5.66% of the positive samples were taken from parks and recreational areas (11). In Poland, eggs of *Toxocara* spp. were identified in various areas of Krakow (30%), Poznan (9.96%), Wroclaw (6%), and it was concluded that urban areas were more contaminated than the rural ones (15). A research of soil contamination in Belgrade (Serbia) estimated overall 41.39% positive of 29 different locations, where *T. canis* eggs were identified in 34.39%, and eggs of *T. cati* and *Toxascaris leonina* in 10.34% of the locations (24).

Developmental parasite forms were identified in 65.9% of the samples taken in the Belgrade area (Serbia) from 1993 to 2002. Rehabilitation measures were implemented in the 2003-2007 period, which resulted in a 45.9% reduction of the contamination.

Additional progress was made in 2008 and 2009 by introduction of special garbage containers with available plastic bags for dog feces. Also, in 2011 some of the city parks were declared as eco zones, while other parks were marked as pet-friendly areas. Finally, in study conducted in 2012 parasite egg contamination of parks was reduced by 40% when compared to the previous survey conducted during the period 2008-2009 (22).

Variations in estimates of contamination of public areas with various developmental parasite forms may be observed for different continents, countries and cities (Table 1).

Research of soil and vegetation contamination in B&H was not often. Results of previous studies of parasite soil contamination conducted in B&H are shown in Table 2.

It is evident that parasitic contamination of soil is highly prevalent and presents a serious public health problem. The Sarajevo Canton area was sampled and tested for parasitic contamination 16 years ago. Since then, a number of owned and particularly stray dogs increased several times in the area, while favorable climatic conditions provide long-time survival of various developmental parasite forms. The aim of the present study was to investigate parasitic contamination of soil and vegetation on different locations in the Sarajevo Canton, and to propose respective measures of rehabilitation.

Material and Methods

Study area. The area of the Sarajevo Canton covers 1,276.9 km^2. The Canton is composed of nine municipalities: Stari Grad, Centar, Novo Sarajevo, Novi Grad, Ilidža, Hadžići, Vogošća, Ilijaš and Trnovo. The area is characterized by a moderate and mild continental climate with average annual temperature of 11.7°C, and precipitation of 900 L/m^2 (37).

Sample collection and testing. During the period from April to October 2015, the total of 300 samples were taken from 55 different locations (Table 3). The soil sampling was carried out in the yards of kindergartens (n=4), primary schools (n=23), highschools (n=1), public playgrounds (n= 8), parks (n=18) and other public places (n=1). The vegetation samples were taken at the same locations.

Using the metal spatula, four soil samples from each locality were taken from the surface covering 25x25cm and 1 cm in depth, each weighting approximately more than 20 g. At each location covered with vegetation, four plant samples were taken using scissors covering the surface of 25x25cm.

The samples were stored at 4°C in the portable refrigerator and sent to the Laboratory for Parasitology, Veterinary Faculty of Sarajevo, B&H. Parasitological examination was carried out using standard techniques (4, 6). Parasitological determination was based on assessment of morphological characteristics and diameter measurement of parasite specimens.

Statistical analysis. Statistical analysis was performed using Minitab ® 17 Statistical Software (Minitab Inc., USA). Chi-square test was used to assess the differences in positive findings among the studied municipalities and locations. P-values less than 0.05 were considered statistically significant.

Results

Conducted survey on 55 locations in the Sarajevo Canton found that 33 (60%) of them were contaminated with parasites. Out of 300 soil and vegetation samples collected in total, 71 (23.66%) were identified as positive. Laboratory testing of 220 soil samples and 80 vegetation samples showed that 59 (26.82%) and 12 (15%) samples were positive, respectively.

Results of soil and vegetatation contamination in different municipalities of the Sarajevo Canton are shown in Table 3, while the results of contamination of the sampled locations are given in Table 4. The frequencies of the positive locations and samples were not significantly different

Table 3. Contamination of soil and vegetation by developing parasite forms in municipalities of the Sarajevo Canton.

Municipality	Locations			Soil samples			Vegetation samples			All samples		
	No	+*	%	No	+*	%	No	+*	%	No	+*	%
Stari grad	3	3	100	12	4	33.33	4	1	25.00	16	5	31.25
Centar	8	6	75.00	32	9	28.12	24	4	16.16	56	13	23.21
Novo sarajevo	12	6	50.00	48	10	20.83	16	2	12.50	64	12	18.75
Novi grad	14	6	42.86	56	13	23.21	12	2	16.66	68	15	22.06
Ilidža	6	3	50.00	24	5	20.83	8	-	-	32	5	15.62
Hadžići	4	3	75.00	16	5	31.25	8	1	12.50	24	6	25.00
Vogošća	3	1	33.33	12	2	16.66	4	-	-	16	2	12.50
Ilijaš	3	3	100	12	8	66.66	4	2	50.00	16	10	62.50
Trnovo	2	2	100	8	3	37.50	-	-	-	8	3	37.50
P=			0.278			0.114			0.486			0.022

*- number of positive samples

Table 4. Contamination of soil and vegetation by developing parasite forms in different locations in the Sarajevo Canton

Areas	Locations			Soil samples			Vegetation samples			All samples		
	No	+*	%	No	+*	%	No	+*	%	No	+*	%
Kindergartens	4	1	25.00	16	1	6.25	4	-	-	20	1	5.00
Primary schools	23	11	47.82	92	22	23.91	8	1	12.50	100	23	23.00
Highschools	1	1	100	4	2	50.00	-	-	-	4	2	50.00
Playgrounds	8	6	75.00	32	7	21.87	8	2	25.00	40	9	22.50
Parks	18	14	77.77	72	27	37.50	56	9	16.07	128	36	28.12
Public areas	1	-	-	4	-	-	4	-	-	8	-	-
P=			0.119			0.052			0.712			0.096

* - number of positive samples

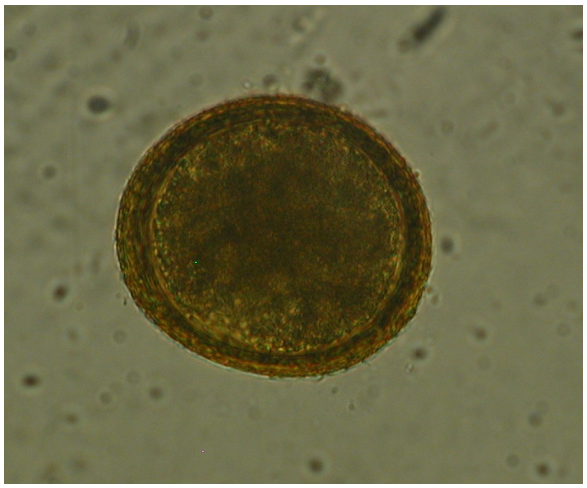

Figure 1. *Toxocara canis* egg

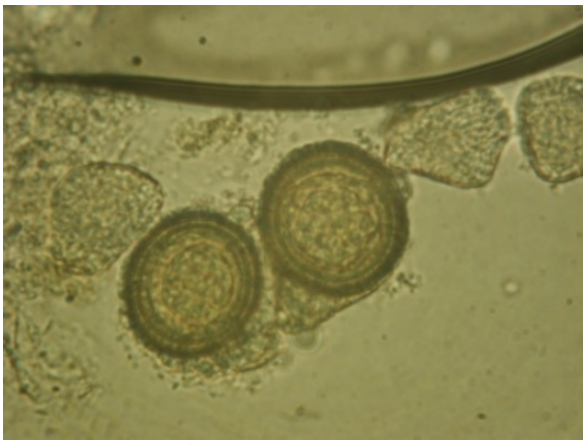

Figure 2. *Taeniid* eggs

among the municipalities unless the soil and vegetation samples were considered together (p = 0.022). The positive samples were most prevalent in Ilijaš (62.5%), and the least in Vogošća (12.5%) (Table 3).

The highest contamination of soil and vegetation was observed in the parks (77.77%) and playgrounds (75%), respectively, although the frequency of positive samples was not significantly different among locations regardless of the type of the sample (Table 4).

Five different developing forms of parasites were found; taeniid eggs, *T. canis*, *Trichuris* spp. and ancylostomatid eggs as well as larvae of nematodes. All the measured *Toxocara* spp. eggs had diameter longer than 75 μm and belonged to *Toxocara canis* species. The most prevalent contamination was observed in parks (77.77%) and playgrounds (75%). Considering the 33 parasite positive locations, the most prevalent cause of contamination were *T. canis* eggs, which were detected in 32 (96.97%) of the locations, followed by nematode larvae (42.42%), *Trichuris* spp. eggs (27.27%) and ancylostomatid eggs (18.18%), while the last prevalent were teniid eggs, which were found only in four locations (12.12%). Similar results were observed with regard to the positive soil and vegetation samples (n=71), where the most prevalent were also *T. canis* eggs (70.42%) followed by nematode larvae (23.94%), *Trichuris* spp. eggs (12.67%), ancylostomatid eggs (8.45%) and taeniid eggs (5.63%).

Some developmental parasite forms identified in the soil

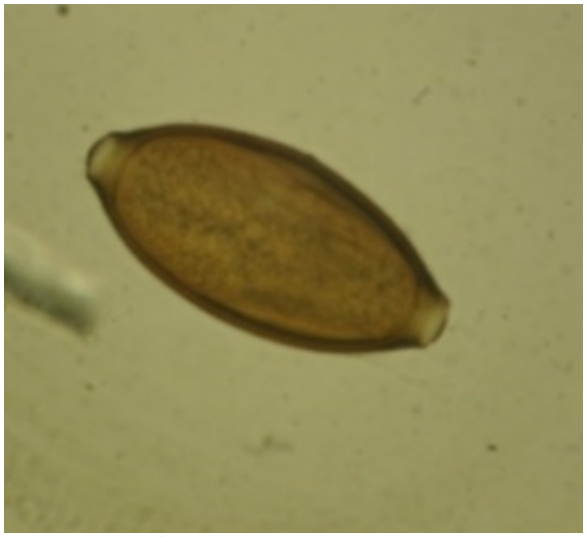

Figure 3. *Trichuris* spp. egg

and vegetation samples are presented in Figures 1, 2, and 3 (Olympus, digital camera, 40X).

Discussion and conclusion

Omeragić (19) detected a higher proportion of parasite-positive locations in Herzegovina than the presented results of parasite contaminated soil and vegetation in the Canton Sarajevo. Also, higher proportions of contaminated locations were identified in other cities and countries including Santiago (Chile), Venezuela (Ciudad Bolivar), Japan (Tokushima), and Turkey (Erzurum) (31).

Smaller proportions of B&H locations contaminated with parasites were identified in the Sarajevo Canton (18), in the area of Visoko (20), and in the area of the Bosnian-Podrinje Canton (21). Smaller prevalence of environmental parasitic contamination were also reported worldwide, such as in Australia (6), Poland (15, 31), Serbia (24), Niger, USA, Argentina, Brazil, Thailand, Turkey, Ireland, Italy, Czech Republic and Slovak Republic (31).

The prevalence of environmental samples positive for parasites reported in this research (26.82%) was lower comparing to the higher prevalence of positive samples previously described in various B&H regions, such as in the Sarajevo Canton (18, 32), in Herzegovina (19) and in the Visoko area (20). Similar results are reported for samples collected in London (29), Australia (6) and Dublin (11). On the other side, smaller proportions of parasite-positive samples were reported in B&H (21), UK (23, 26), Italy (8), USA (5), Australia (2) and Egypt (14).

As in the earlier studies in B&H (18, 19, 20), the present study also identified soil and vegetation from the parks and playgrounds as the locations with the highest parasite contamination. Outdoor facilities such as public playgrounds and parks include large areas available for both, owned and stray dogs. Unlike the B&H studies, high parasite contamination of public playgrounds and parks was not reported in other countries (2, 3, 4, 5, 8).

Predomininant parasite species in this study was *T. canis*, being detected in 96.97% of positive locations and 70.42% of positive samples. Such finding is in agreement with the results from previous studies on canine parasites in the Sarajevo area (7, 13, 17), which also observed high prevalence of T. canis infection. In addition, *T. canis* was also described as the most common parasite in dogs worldwide (3, 4, 8, 11, 15, 22, 25, 26, 31).

The reported developmental parasite forms represent a permanent risk to human health. Thus, it is necessary to implement measures to reduce the soil and vegetation contamination according to relevant legislation. The implementation should involve active participation of all interested parties, particularly pet owners, veterinarians, physicians, and environment protection experts, where a special attention should be paid to permanent education at all levels, from kindergartens to specialized target audience such as competent authorities and inspection services.

Additionally, it is equally important to timely adopt and implement relevant legislation to appropriately regulate keeping, handling and protection of pet animals as well as the obligations of their owners with regard to pet handling in outdoor public areas. Furthermore, veterinarians should play an essential role concerning registration and identification of the animals, prevention, diagnostics and treatment of animal diseases, and continuous personal education and education of animal owners as well. A pet owner and/or caretaker must have a full responsibility for the pet, particularly with respect to create satisfactory and pet-friendly conditions for animal keeping. Also, it is of crucial importance for the animal owners to cooperate with veterinarians to timely register and identify animals, and to protect their health and welfare. Finally, equal importance shall be put on education of children and their parents on keeping adequate personal hygiene, especially after the contacts with pets, any outdoor activities, and before food consumption.

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Kontaminiranost tla i vegetacije parazitima i razvojnim oblicima parazita na području Kantona Sarajevo

Sažetak

Uvod

Čovjek se parazitima, osim neposrednog kontakta, može infestirati i preko kontaminiranog tla ili biljaka, unoseći razvojne oblike parazita direktno, hranom ili vodom. Prema podacima WHO (2015), više od 2 milijarde ljudi u svijetu je zaraženo parazitima koji se mogu prenijeti preko tla. Kontaminacija tla i biljaka parazitima i razvojnim oblicima parazita može biti ozbiljan javno-zdravstveni problem, jer se jaja i larve parazita mogu dugo održati u prirodi pod nepovoljnim uvjetima.

Pošto su na području Kantona Sarajevo pretrage provođene prije 16 godina, broj pasa je višestruko porastao, a klimatske prilike omogućavaju dugotrajno održavanje razvojnih oblika parazita, cilj rada je bio da se istraži kontaminiranost tla i biljne vegetacije parazitima i razvojnim oblicima parazita na određenom broju lokaliteta Kantona Sarajevo i da se predlože mjere sanacije.

Materijal i metode

Područje Kantona Sarajevo sastoji se od devet općina, prosječna nadmorska visina je 511m, a klima je umjereno kontinentalna. Prosječna godišnja temperatura iznosi 9,5°C, a količina oborina je oko 900 l/m^2. U periodu od aprila do oktobra 2015. godine uzeto je 300 uzorka, 220 uzoraka tla i 80 uzoraka biljne vegetacije sa 55 različitih lokaliteta Uzorkovanje tla obavljeno je u dvorištima obdaništa (4), osnovnih (23) i srednjih škola (1), igralištima (8), parkovima (18) i javnim površinama (1).

Uzorkovanje biljne vegetacije obavljeno je na istim lokacijama sa kojih su uzeti uzorci tla. Sa svakog lokaliteta, sa površine 25x25 cm^2, uzeta su metalnom lopaticom 4 uzorka tla (sa dubine do 1cm), tako da je uzorak sadržavao više od 20g i 4 uzorka biljne vegetacije, korištenjem makaza.

Parazitološko ispitivanje provedeno je u Laboratoriju za parazitologiju Veterinarskog fakulteta u Sarajevu, primjenom standardnih tehnika. Statistička analiza rezultata izvršena je pomoću statističkog softvera Minitab 17. Razlike u učestalosti pozitivnih nalaza između općina ili istraživanih lokaliteta ispitane su Chi-kvadrat testom. P vrijednosti manje od 0,05 smatrane su statistički značajnim.

Rezultati i interpretacija

Pretragama zemljišta sa 55 lokaliteta kantona Sarajevo pozitivna su bila 33 (60%) lokaliteta, a od 300 uzoraka pozitivnih je bilo 71 (23,66%). Od 220 uzorka tla, pozitivnih je bilo 59 (26,82%), a od 80 uzoraka biljne vegetacije pozitivnih je bilo 12 (15%). Učestalost nalaza pozitivnih lokaliteta i uzoraka nije se statistički značajno razlikovala među općinama, osim ako se uzorci tla i vegetacije posmatraju zajedno (p=0,022). Naime, pozitivnih uzoraka nađeno je najviše u Ilijašu (62,5%), a najmanje u Vogošći (12,5%). Ustanovljeno je 5 vrsta razvojnih oblika parazita iz klase Cestoda: jaja *Taeniidae*, klase Nematoda: j. *Toxocara canis*, j. *Trichuris* spp., j. *Ancylostomatidae* i larve *Nematoda*.

Od 60% pozitivnih lokaliteta, jaja *Taeniidae* ustanovljena su na 4 (12,12%), j. *Toxocara canis* na 32 (96,97%), jaja *Trichuris* spp. na 9 (27,27%), j. *Ancylostomatidae* na 6 (18,18%) i larve Nematoda na 14 (42,42%). Od 23,66% pozitivnog uzorka tla i biljne vegetacije, jaja *Taeniidae* ustanovljena su u 4 (5,63%), jaja *Toxocara canis* u 50 (70,42%), jaja *Trichuris* spp. u 9 (12,67%), j. *Ancylostomatidae* u 6 (8,45%) i larve *Nematoda* u 17 (23,94%) uzoraka. Najveća kontaminiranost tla i biljne vegetacije ustanovljena je u parkovima (77,77%) i igralištima (75%), kao i u ranije provedenim istraživanjima na području BiH. Javni prostori, kao što su igrališta i parkovi imaju znatno veću površinu i najčešće ih koriste vlasnicikućnih ljubimaca za šetnju, a takvi prostori su dostupni i psima bez vlasnika.

Zaključci

Ustanovljeni razvojni oblici parazita životinja mogu predstavljati permanentnu opasnost za zdravlje ljudi. Potrebno je provoditi mjere za smanjenje kontaminiranosti tla i biljne vegetacije i koordinirati ih sa sistemskim rješenjima (zakonskom regulativom), uz doprinos vlasnika životinja, veterinara, ljekara, ekologa, roditelja i svih drugih koji su involvirani u navedenu problematiku, uz permanentnu edukaciju.

Veoma je važno donošenje i provođenje zakonske regulative kojom se regulira zaštita i način držanja životinja, utvrđuju uvjeti za njihovo držanje i obaveze vlasnika kućnih ljubimaca pri izvođenju životinja na javne površine. Veoma je bitna uloga veterinara u registraciji i identifikacija životinja, preventivi oboljenja, dijagnostici i liječenju bolesnih životinja, te kontinuiranoj osobnoj edukaciji vlasnika životinja.

Osobe koje posjeduju ili se staraju o životinji imaju obavezu da se o njoj brinu, a što podrazumijeva stvaranje uvjeta životinji da zadovolji svoje osnovne životne potrebe. Isto tako veoma je važno za vlasnike životinja suradnja sa veterinarima u zaštiti zdravlja, registraciji i identifikaciji životinja, osobnoj edukaciji i pridržavanju propisa kada je u pitanju držanje životinja.

Osobna higijena djece i odraslih, osobito poslije kontakta sa kućnim ljubimcima i bilo kakvih aktivnosti na otvorenom, a prije konzumiranja hrane.