Role of cat and dog faeces in the contamination of sand playgrounds in public parks by *Toxocara* spp.

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Summary

Toxocariasis is one of the most important parasitic zoonoses affecting human health. The main source of toxocariasis in humans is dog and cat faeces, which are primarily responsible for the contamination of urban areas with *Toxocara* spp. eggs. In this study, the relationship between dog or/and cat faeces and contamination of sand playgrounds in public parks with *Toxocara* spp. eggs was investigated. A total of 596 sand and 276 faecal samples (148 dog and 128 cat faeces samples) were collected from 52 public parks in Samsun. *Toxocara* spp. eggs were identified in 7% of sand samples, 33% of cat faeces samples and 9.5% of dog faeces samples. A positive correlation was found between the presence of faeces and the contamination of sand samples. The incidence of sand contamination was increased 8.3 times if a park contained dog or/and cat faeces, and the incidence was much greater if the faeces were infected with *Toxocara* spp. ova. Cat faeces had a greater effect on the contamination of sand than did dog faeces. The risk was 12.5 and 27 times greater if a park contained only cat faeces and infected cat faeces, respectively. However, no *Toxocara* spp. eggs were found in sand samples from parks that contained only dog faeces.

Keywords: Toxocariasis, public health, cat, dog, faeces, playground

Toxocara spp. are common parasites living in the gastro-intestinal track of dogs and cats, particularly puppies and kittens, and they are zoonotic nematodes of importance for public health (22, 31). Infection in dogs and cats occurs via horizontal or vertical transmission, whereas humans are generally infected by accidental ingestion of embryonated eggs. After ingestion of eggs by humans, infective larvae cannot complete their life cycle and migrate abnormally to different tissues, including the eyes, liver, lungs, brain or other organs, which is a condition termed Larva Migrans Syndrome (LMS), which includes Visceral Larva Migrans (VLM), Ocular Larva Migrans (OLM), and Covert Toxocariasis (CT). Furthermore, atopic and/or neurological symptoms have been reported. Larvae may cause severe infections in different mammals other than humans and in birds. These animals can be paratenic hosts for definitive hosts, canids and felids, as well as humans ingesting infective larvae in undercooked meat. In urban areas, rodents and birds, which can be paratenic hosts of toxocariasis, are im-

portant food resource for cats. Additionally, stray dogs and cats eat waste food, or they are regularly fed by residents. This food also creates a risk of toxocariasis in urban areas (28, 33, 34).

Adult roundworms are parasitic helminths that can produce up to 200,000 eggs a day (13). Morgan et al. (29) reported up to 3,700 eggs per gram of faeces passed by juvenile puppies (< 3 months) whose average faecal output was 36.8 g per a day. Unembryonated eggs passed in faeces can be infective for 9-15 days under optimum conditions, but generally embryonated eggs develop over 3-6 weeks, depending on environmental conditions, such as the soil type and climate (30). Embryonated eggs, which contain infective larvae, are very resistant and can survive for at least one year (22).

Toxocariasis has been reported world-wide, including from the Arctic (16), with infection rates of 1.2% to 64.7% in dog faeces (5, 8, 28, 32) and 0.5% to 76% in cat faeces (2, 5, 12, 20). Children are at the highest risk of toxocariasis because of their tendency to put

things in their mouths and because they do not often wash their hands. They often play with soil, especially in sandpits, and put their fingers into their mouths (31). Therefore, public parks have an important role in the transmission of toxocariasis to children. Many studies have determined the contamination level of soil and/or sand samples in public parks, with the prevalence ranging from 0.3% to 68.1% worldwide (7, 11, 23, 26, 27, 35).

In urban areas in Turkey, unfenced public parks are accessible to stray dogs and cats. For example, stray dogs sleep in such places, and stray cats defecate in sand playgrounds. Thus, dogs and cats are regular visitors to public parks and are thought to be chiefly responsible for their contamination with *Toxocara* spp. eggs. However, their role in transmission is not fully understood. The aim of this study was to ascertain the relationship between cat or/and dog faeces and the contamination of sand playgrounds with *Toxocara* spp. eggs in public parks in Samsun, a large city in Turkey.

Material and methods

Study area. This study was conducted in the city of Samsun (41°17' N, 36°20' E), Turkey, on the coast of the Black Sea. The monthly temperature ranges from 7.0 to 23.4°C, rainfall from 31.8 to 84.1 kg/m², and number of rainy days from 5.9 to 13.6. Over 660,000 inhabitants live in the city, whereas the number of free-roaming stray dogs and cats is estimated at several thousand. The study areas were public parks located near the city center, including playgrounds with unfenced sandpits which allow free access for cats and dogs.

Collection of sand and faecal samples. Fifty-two public parks with playground areas of 40-110 m² were surveyed in Samsun. In each park, a 300 g sand sample to a depth of approximately 5 cm below the sand surface was collected from every 5 m² of playground. In total, 596 sand samples were collected early in the morning on non-rainy days between May and August 2013. The samples were placed in plastic bags, labeled with information about location, time and date of collection, taken to the laboratory, and stored at 4°C. At the same time, all dog and cat faeces in the public parks were collected. The faeces were identified as dog or cat faeces on the basis of their size and shape and the presence of food residues. Cat faeces were generally found under slides in playgrounds, and dog faeces were collected from almost everywhere in public parks. A total of 276 faecal samples, namely 148 dog and 128 cat faeces, were collected from the ground. The samples were placed in plastic vials, which were then labeled with information about the source species, location, time and date of collection, taken to the laboratory, and stored at 4°C.

Parasitological investigation procedure. The sand samples were processed according to the methodology of Kazacos (18) with some modifications. After homogenization, 50 g of a representative sample of 300 g of collected sand was mixed with distilled water and 1 ml of tween 40. The samples were then filtered through a 250 µm filter, and the residue was centrifuged with distilled water at 4000 g

Tab. 1. Number of sand and faecal samples in public parks

Group of parks	Number of parks	Number of sand samples	Number of faecal samples
FR	36	432	276
NFR	16	164	–
Total	52	596	276
CFR	6	60	46
DFR	11	136	32
CDFR	19	236	198
NFR	16	164	–
Total	52	596	276

for 3 min. This procedure was repeated three times, and the final sediment was centrifuged with NaCl solution (density: 1.18) for flotation.

Individual faecal samples were mixed with zinc chloride (ZnCl₂, 800 g/liter; density: 1.50) and then subjected to centrifugation and flotation to separate *Toxocara* spp. eggs, which were then identified on the basis of morphological criteria under a standard light microscope (17, 36).

The public parks were divided into five groups for the evaluation of results: faeces recorded (FR), no faeces recorded (NFR), only cat faeces recorded (CFR), only dog faeces recorded (DFR), both cat and dog faeces recorded (CDFR). The number of parks, sand samples and faecal samples by group are shown in Table 1.

Data analysis. The proportional distributions of *Toxocara* spp. in the sand samples collected from public parks were calculated, and the Chi-Square Test and Fisher's Exact Test were applied. In addition, the odds ratio was calculated to determine the risk coefficient. A probability of $P < 0.05$ was considered significant. Statistical analyses were performed with the software package NCSS 9.0.5.

Results and discussion

In total, 42 (7.0%) out of 596 sand samples collected from 9 (17.3%) out of 52 public parks were contaminated with *Toxocara* spp. eggs. A total of 124 *Toxocara* spp. ova, with a mean of 2.9 (range: 1-15) per 50 g, were collected from contaminated parks. Larvae and embryos were found in 99 and 7 of them, respectively, whereas 18 eggs were in uninfected forms. Regarding faecal examination, 55 (19.9%) out of 276 samples were infected with *Toxocara* spp.: 57.5% of sandpit samples, 33.0% of cat faeces samples and 9.5% of dog faeces samples. The categories of contamination in parks are shown in Table 2.

Sandpit contamination was recorded in 9 public parks, and 8 of them contained faeces. The occurrence of faeces or infected faeces in parks was positively correlated with the risk of contamination of sand samples with *Toxocara* spp. ova ($P < 0.001$). The sand contamination risk was 8.3 times higher if the park contained faeces and 23.7 times higher if the park contained infected faeces (Tab. 3). Seventeen public parks contained only cat faeces (CFR) or only dog faeces (DFR). Eight sand samples were contaminated with *Toxocara*

Tab. 2. Prevalence of *Toxocara* spp. eggs in sand and faecal samples in public parks

Group of parks	Contaminated parks		Contaminated sand samples		Infected faecal samples	
	n	%	n	%	n	%
FR	8	15.4	40	6.7	55	19.9
IFR*	6	11.5	35	5.9	55	19.9
NFR	1	1.9	2	0.3	–	0
Total	9	17.3	42	7.0	55	19.9
CFR	3	5.8	8	1.3	16	5.8
ICFR**	2	3.8	5	0.8	16	5.8
DFR	–	0	–	0	2	0.7
CDFR	5	9.6	32	5.4	37	13.4
NFR	1	1.9	2	0.3	–	0
Total	9	17.3	42	7.0	55	19.9

Explanation: * IFR – infected faeces recorded; ** ICFR – infected cat faeces recorded

Tab. 3. Risk of contamination of sand samples with *Toxocara* spp. eggs in public parks with faeces

Sand samples		Contaminated sand samples		
Group	n	n	%	Risk
FR	432	40	9.3	8.3
NFR	164	2	1.2	1
P-value			< 0.001	
IFR	156	35	22.4	23.7
NFR	164	2	1.2	1
P-value			< 0.001	

Tab. 4. Risk of contamination of sand samples with *Toxocara* spp. eggs in public parks with only cat or dog faeces

Public park		Contaminated sand samples		
Group	n	n	%	Risk
FR	60	8	13.3	12.5
NFR	164	2	1.2	1
P-value			< 0.001	
ICFR	20	5	25	27
NFR	164	2	1.2	1
P-value			< 0.001	
CFR	60	8	13.3	3.6
DFR	136	0	0	1
P-value			< 0.001	

spp. ova in CFR parks, but no contamination was found in DFR parks. The sand contamination risk was 12.5 times higher in FR parks than in NFR parks ($P < 0.001$). Moreover, the risk was 27 times higher if the cat faeces were infected with toxocariasis ($P < 0.001$). Regarding the CFR and DFR parks, sand contamination with *Toxocara* spp. ova was 3.6 times more likely with the occurrence of cat faeces than with the occurrence of dog faeces ($P < 0.001$) (Tab. 4).

Toxocara spp. is an important zoonotic agent, and human toxocariasis is increasing worldwide, espe-

cially in tropical and subtropical regions. The seroprevalence of toxocariasis infection among humans was more than 20% in some countries, while the rate was much higher in tropical and subtropical regions (21). Toxocariasis is widespread worldwide in dogs and cats, which play the main role in the contamination of the environment with *Toxocara* spp. eggs in urban areas (38). Many studies have reported on the prevalence of toxocariasis in cats and dogs, but only a few of them have provided information on the

toxocariasis infestation of dog or cat faeces collected in public parks. Dubin et al. (6) reported that 9.4% and 20% of 105 dog faeces collected from two city parks were infected with *Toxocara* spp. in Pennsylvania. While the ranges of the prevalence of toxocariasis were almost the same for cats (3.9%-35.3%) and dogs (3.7%-35.7%) in Turkey (14), *Toxocara* spp. eggs were present at a significantly higher level in cat faeces than in dog faeces collected from public parks in the present study ($P < 0.001$). This result was consistent with that of Mizgajska-Wiktor et al. (28), who reported *T. cati* was more frequent in urban areas in Poland.

Public parks play a critical role in the infection of humans by *Toxocara* spp., particularly children. There was a positive association between seropositivity for toxocariasis in children who had played in public parks and contamination of the same public parks with *Toxocara* spp. ova (25). Public parks also create contamination risk for birds and rodents, which are paratenic hosts of toxocariasis (34). It is suspected that cats and dogs play a leading role in the contamination of parks. However, there is little information about the relationship between the contamination of public parks with *Toxocara* spp. ova and cat or dog faeces collected in these parks. Dubin et al. (6) studied parasite infestation of soil samples and dog faeces collected in two city parks in Pennsylvania, and found that ascarid infestation amounted to 9.5-12.5% in soil samples and 9.4-20% in faecal samples. Avcioglu et al. (1) reported that 35.3% of faecal samples and 14% of soil samples collected in public parks in Erzurum, Turkey, were contaminated with *Toxocara* spp. ova. Dado et al. (4) and Sorgan et al. (35) investigated both soil and faecal samples from public parks, but did not find *Toxocara* spp. eggs in the faeces. Mandarino-Pereira et al. (24) reported *Toxocara* spp. infestation levels of 4% in soil samples and 11% in dog faeces in Brasil. In the present study, *Toxocara* spp. infestation was found in both sand and faecal samples collected in public parks, and there was a positive correlation between sandpit

infestation with *Toxocara* spp. ova and faecal presence. The presence of dog and/or cat faeces in the public parks increased the contamination risk for sandpits. Moreover, the risk was almost 3 times higher if the faeces were infested with *Toxocara* spp. ova.

Contamination of public parks with *Toxocara* spp. is a result of the long-term accumulation of eggs, and it is multi-factorial, depending on such factors as the presence and number of cats and dogs and their faeces, the infectivity status of their faeces, and the occurrence of stray/owned cats and dogs in the city. Thus, it is difficult to determine whether dogs or cats play the main role in the contamination of public parks. Some studies have investigated the role of *T. canis* and *T. cati* eggs in the contamination of public parks. Khademvatan et al. (19) reported that the majority of *Toxocara* spp. ova obtained from soil samples collected from public parks in Ahvaz, Iran, were *T. cati* (28% of *T. cati*, 5.7% of *T. canis*), whereas in another study *T. canis* constituted the majority of ova (12% of *T. canis*, 3% of *T. cati*) in public parks in Kayseri, Turkey (3). Furthermore, dogs are hosts not only to *T. canis* but also to *T. cati*, whereas cats can only host *T. cati* (9). In the present study, most of the parks contained both cat and dog faeces (CDFR) and 32 (13.6%) out of 236 sand samples from these parks were contaminated with *Toxocara* spp. ova. However, 17 public parks contained only cat faeces (CFR) or only dog faeces (DFR). Contamination rates were almost the same (13.3%) in CFR parks, but no eggs were found in DFR parks. Overall, the risk of contamination of sandpits with *Toxocara* spp. ova was 3.6 times greater in CFR parks than in DFR parks. The same results were obtained for *T. cati* ova in public parks (15, 27). This situation might be explained by the tendency of cats to defecate in sand, whereas dogs will defecate almost anywhere in a park (37).

Public parks play an important role in the transmission of *Toxocara* spp. eggs to humans, particularly children, and sandpits are a recognized source of infestation in public parks (5, 22). This study revealed a positive correlation between the presence of faeces and playground contamination. The risk almost tripled, if faeces were infested with *Toxocara* spp. In addition, the presence of cat faeces created a greater risk of contamination in playgrounds. This should be taken into account in efforts to prevent the contamination of public parks with eggs of *Toxocara* species, although the role of *T. cati* is not clear in human toxocariasis (10).

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