Annals of Parasitology 2019, 65(1), 65-70
doi: 10.17420/ap6501.183

Original papers

Soil contamination with geohelminths in children's play areas in Szczecin, Poland

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ABSTRACT. The presence of invasive forms of parasites in the soil represents a potential threat to public health, especially for children. The aim of the study was to determine the degree of contamination with geohelminth eggs of soil samples collected from sandpits and playgrounds in the Szczecin area. The findings showed overall prevalence of soil samples contaminated with geohelminth eggs in the soil and sand of play areas in Szczecin at 41.4%. Four species of parasites have been identified: *Toxocara* spp., *Toxascaris leonina*, *Dipylidium caninum* and *Trichuris* spp. The greatest proportion of infected samples from sandpits contained *Toxocara* spp. eggs, comprising 22.7% of samples; however, the dominant parasite found in the samples from the play areas was *Toxascaris leonina* (28.6%). As contamination of the soil with parasite eggs constitutes a risk of infection with parasitic diseases in humans, it is necessary to monitor the presence of geohelminth eggs in soil and to implement activities aimed at prevention of their occurrence.

Key words: geohelminths, *Toxocara* spp., *Dipylidium caninum*, *Trichuris* spp., *Toxascaris leonina*

Introduction

Studies indicate that parasitoses currently represent a serious public health problem around the world [1–3]. A key threat to humans is posed by animal parasites, which can sometimes cause very serious diseases [4,5]. A wide range of studies indicate high levels of soil contamination by eggs of geohelminth and oocysts of protozoan parasites which can infect healthy animals and people, and contact with contaminated soil is given as one of the most common causes of infection [5,6]. Although wild animals, such as foxes, are the most common parasite vectors, domestic cats and dogs also represent a considerable problem, partly due to their steadily increasing population [7,8]. These pets have access to unfenced recreational areas, such as parks, sandpits and play areas [6,9,10] and with regard to the latter, children are regarded as one of a group at highest risk of infection by parasitic zoonoses [5,6,11]. The most common causes of infection are contact with potentially contaminated soil while playing in fields, or handling various food products with dirty hands [11,12].

The prevalence and intensity of infection with nematodes in dogs has been found to be greatest in the spring-summer season. As this is also the time at which children spend the most time playing outside, the risk of infection can be seen to increase during this period due to greater levels of contamination of invasive forms of parasites in the environment. In addition, a lack of education regarding the basic principles of hygiene, such as lack of or inadequate hand washing after playing in sandpits or after playing with animals, further increases the risk of infection [9]. A phenomenon which can further increase the chance of infection is geophagia, which is quite often observed in children. Although no clearly defined reasons have been proposed for its occurrence, the phenomenon has been classified as a disorder with a psychological basis, and one which is affected by various psychological and biological factors [13,14].

Table 1. The occurrence of geohelminth eggs in children's play areas

	Examined samples	Positive samples n (%)	Number of samples with detected eggs			
			Toxocara spp.	*Toxascaris leonina*	*Trichuris* spp.	*Dipylidium caninum*
Sandpits	22	9(40.9%)	5(22.7%)	3(13.6%)	4(18.2%)	1(4.6%)
Playgrounds	7	3(42.9%)	1(14.3%)	2(28.6%)	–	1(14.3%)
Total	29	12(41.4%)	6(20.7%)	5(17.2%)	4(13.8%)	2(6.9%)

The most common parasitic zoonosis in humans is toxocarosis, caused mainly by dog roundworm (*Toxocara canis*) or feline roundworm (*Toxocara cati*) [4,8,15,16]. The wide prevalence of roundworms in soil has been attributed to the resistance of their eggs to adverse environmental conditions and the considerable reproductive potential of *Toxocara* spp. [5,8]. Toxocarosis is a dangerous zoonotic disease, which can occur in humans as viceral, brain and latent forms, as well as eye forms, which can cause serious damage to the seeing organs and lead to blindness in extreme cases [4,17]. The parasite is especially dangerous for children. Due to the severe course and difficulty in treating the disease, the European Council for Domestic Animal Parasites recommend dogs be dewormed at least four times each year to minimize the risk of contracting the parasite [17].

The aim of this study was to determine the degree of contamination with geohelminth eggs in soil samples collected from sandpits and children's play areas in the Szczecin area.

Materials and Methods

The material used in the tests comprised soil samples from the top layer of the soil profile, i.e. within 3 cm from the surface, collected from small neighborhood play areas in the Szczecin area (n=29). This material was taken during the period March to May 2017. After collection, all samples were stored in sealed, labelled plastic bags in a cool place until examination. Soil examination was carried out soon after collection.

Soil samples were analyzed according to Mizgajska-Wiktor [18]. In this method, a saturated solution of $NaNO_3$ was used as a flotation medium. The tests were carried out in triplicate. Soil samples (dry and sifted) were placed in flat-bottomed flasks, and 5% NaOH was added to separate the eggs from the soil particles. The contents of the flasks were stirred and allowed to settle for one hour, before being shaken for 20 minutes at 100 rpm. After this vigorous mixing, they were moved into test tubes and centrifuged for five minutes at 1500 rpm, following which, the supernatants were removed from the test tube and replaced with H_2O. The mixture was centrifuged again for five minutes at 1500 rpm. After spinning, the H_2O was discarded, a saturated $NaNO_3$ solution was added to the pellet and centrifuged for five minutes at 1500 rpm. The tubes were transferred to tripods and saturated $NaNO_3$ solution was added with a pipette to form a convex meniscus. A coverslip was placed over the sample, and after ten minutes it was moved to a microscope slide. These preparations were then used for microscope analysis. As it is difficult to distinguish *Toxocara canis* from *Toxocara cati* eggs due to their considerable morphological similarities, they were only identified to genus level (i.e. *Toxocara* spp.).

Results

The study was performed on 29 soil samples collected from sandpits (n=22) and children's play areas (n=7) (Table 1). Parasite eggs were found in 41.4% (12/29) of all samples, with 40.9% (9/22) of positive samples from the sandpits and 42.9% (3/7) positive samples from the play areas. Four types of parasite were identified: *Toxocara* spp., *Toxascaris leonina*, *Dipylidium caninum* and *Trichuris* spp. Of the sandpits, the greatest proportion of positive samples contained *Toxocara* spp. eggs (22.7%, 5/22); however, the dominant parasite identified in the play areas was *Toxascaris leonina* (28.6%, 2/7). The eggs of *Trichuris* spp. were found only in sandpit samples, in four of 22 samples (18.2%). The lowest number of positive samples was observed in case of *Dipylidium caninum*, which was found in 6.9% of all analyzed samples (2/29). In 13.8% of samples, eggs from more than one species of parasite were found.

Table 2. Proportion of soil samples contaminated with parasite eggs in various countries

Country	Site of study	*Toxocara* spp.	*Toxascaris leonina*	*Dipylidium caninum*	*Trichuris* spp.	References
Poland (Elbląg)	Backyard	18%	–	–	–	Jarosz [27]
	Playgrounds	4.5%	–	–	–	
Poland (Gdańsk)	Sandpits	6.2%	–	2.5%	–	Rokicki et al. [26]
Poland (Katowice)	Recreational areas	48.15%	–	–	–	Grygierczyk et al. [28]
	Heavily urbanised areas	34.21–67.39%	–	–	–	
	Playground	47.36%	–	–	–	
Poland (Lębork)	Sandpits	28%	–	–	–	Ronkiewicz et al. [29]
Poland (Lublin)	Recreational areas	15%	–	– 1	8.3%	Bojar and Kłapeć [20]
Poland (Lublin)	Organic farms	23.52%	–	–	0.98%	Kłapeć [30]
Poland (Lublin)	Organic farms	21.3%	–	–	8.2%	Kłapeć and Borecka [31]
	Conventional farms	34.6%	–	–	34.6%	
Poland (Łódź)	Sandpits	3.79–4.55%	–	–	–	Błaszkowska et al. [22]
	Playgrounds	8.33–9.85%	–	–	–	
Poland (Warszawa)	Dog shelters	0.8–3.8%	4.2–12.7%	–	42.7–57.5%	Borecka [32]
Poland (Wrocław)	Square near sidewalks	10.9%	–	–	9.1%	Perec-Matysiak et al. [33]
	Yard	–	–	–	7.3%	
Belgium	Public play area-sandpits	14%	–	–	–	Vanhee et al. [23]
	Kindergarten-sandpits	2%	–	–	–	
Germany	Sandpits	6.5–41.3%	–	–	–	Kleine et al. [4]
Portugal	Public parks	50%	–	–	–	Otero et al. [21]
	Playground sandpits	85.7%	–	–	–	
Russia	Urban areas	23.3%	3.33%	–	–	Moskvina et al. [11]
Slovakia	Public places – two villages	3.03–34.37%	3.13–15.15%	–	13.13%	Pipiková et al. [1]
Iraq	Public parks	21.7%	–	–	8.7%	Taher [2]
	Playgrounds	23.1%	–	–	7.7%	
India	Public spaces-parks, playgrounds	3.75%	–	–	–	Divyamol and Jeyathilakan [24]
	Dog breeding areas	8%	–	–	–	
Mexico	Public parks	–	–	21.7%	15.3%	Núñez et al. [3]
Brazil	Public parks	8.8%	–	–	6.8%	de Moura et al. [6]

Discussion

The soil-transmitted helminths (STH) comprise a group of parasitic nematodes which are typically present in the soil and on the surface of fruit and vegetables, and infect humans through contact with invasive eggs or larvae. The presence of invasive forms of parasites in the soil is a potential threat to public health, especially for children. Manini et al. [19] report a proportional relationship between the degree of contamination of soil with invasive *Toxocara* spp. eggs and the frequency of occurrence of anti-*Toxocara* antibodies in children. This has been linked to their play habits and their tendency to put their hands in their mouths. Kroten et al. [15] found the overall seroprevalence for toxocariasis to be 3.0 % in preschool children and 7.7 % in school children from northeastern Poland.

The exceptional resistance of geohelminth eggs toward adverse environmental conditions make possible to remain in soil for many years, thus increasing the risk of infection to humans through contact with the contaminated soil. For this reason, recent years have seen a number of studies aimed at not only determining the extensity of infection among cats and dogs, but also the prevalence of parasite eggs in the soil of parks, play areas, backyards and gardens in both urban and rural areas, as a risk factor for the transmission of various zoonoses [20–24].

Toxocara spp. eggs are the most commonly identified parasite eggs identified in soil samples in various parts of the world [11,22,25]. The proportion of samples contaminated with these eggs typically vary from 0 [3] to as much as 85.7% [21] (Table 2). In addition, our present findings indicate that the dominant parasite in the soil samples to be *Toxocara* spp: its eggs were identified in 20.7% of samples taken from sand obtained from sandpits and from play areas. These results are greater than those identified by Bojar and Kłapeć [20], who confirm the presence of *Toxocara* spp. eggs in 15% of samples of soil taken from recreational areas. However, a greater proportion of contaminated samples was reported by Kleine et al. [4] in Germany (23.2%), and Kroten et al. [15] in parks in northeastern Poland (42.5%).

Another geohelminth whose presence is often identified in environmental samples is *Trichuris* spp. In the present study, it was found to be present in 18.2% of samples taken from sandpits, a figure many times higher than that obtained by Papajová et al. [25] in Slovakia (3.13%) or Taher [2] in Iraq (8.7%).

The eggs of *Toxascaris leonina*, another nematode, were found in 13.6% of samples taken from sandpits, which corresponds with the results given by Moskvina et al. [11], who report its occurrence to be less common in soil samples than *Toxocara* spp. This finding is comparable with those obtained by Pipiková et al. [1], who report its extensity of infection in sand samples in one village to be 15.15%.

While the tapeworm *Dipylidium caninum* was observed in only 6.9% of samples in the present study, it has demonstrated significantly higher contamination of soil samples in Mexico. Núńez et al. [3] found its eggs to be present in 21% of soil samples taken from public parks. This result is more than eight times higher than that obtained by Rokicki et al. [26] in Gdańsk, Poland (2.5%).

Methods of protecting sandpits against contamination by zoonotic parasites is gaining popularity [22]. The most effective approach appears to be using fencing or sandpit covers to limit access to sandpits and play areas by animals, this being an important link in the reproductive cycle of geohelminths. Błaszkowska et al. [22] note that these measures can reduce the chance of obtaining positive sand samples sixfold compared to unprotected areas.

In conclusions, the findings revealed the prevalence of soil contamination with geohelminth eggs in the soil and sand of play areas in Szczecin to be 41.4%. *Toxocara* spp. eggs were most commonly observed in the soil and sand samples, while *Dipylidium caninum* was observed the rarest. Contamination of soil with parasite eggs represents a risk to health and the potential to develop parasitic illnesses in people; it is necessary therefore to monitor the occurrence of geohelminth eggs in soil and take measures to prevent their occurrence.

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Received 30 November 2018
Accepted 06 January 2019