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Feline intestinal parasites in Finland: prevalence, risk factors and anthelmintic treatment practices

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Abstract

The aim of this study was to estimate the prevalence of feline intestinal parasites in Finland and to determine the possible risk factors for infection. Altogether 411 feline fecal samples were analyzed with a flotation method to reveal helminth eggs and protozoan oocysts. Of the samples, 402 were also screened for *Giardia* species antigens with a commercial enzyme-linked immunosorbent assay kit. The cat owners completed a questionnaire. *Toxocara cati* prevalence was 5.4% and *Toxascaris leonina* 0.2%. *Taenia* species eggs were found in 1.5% of the samples and *Isospora felis* in 0.7%, whilst 3.2% of the samples tested positive for *Giardia* species antigen. Risk factors for *Toxocara*/*Toxascaris* species infection included being a non-pedigree cat, having access to the outdoors, living outside of the cities and receiving home-made food. Pedigree cats were at greater risk of contracting *Giardia duodenalis*. The majority of the cat owners (62.4%) treated their cat with anthelmintics 2–4 times per year.

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Introduction

Cats are popular pets and their role in veterinary medicine is growing. In Finland there are an estimated 800,000 domestic cats (Pirkko Syrjänen and Berner Oy, personal communication). Feline intestinal parasites are an important concern for owners; hence, pet cats are commonly treated with anthelmintics. The treatment decision is rarely based on diagnosis or observed parasite infection; apparently, cats routinely receive anthelmintics as interval treatments. For example, over 100,000 doses of a pyrantel embonate product alone, labeled only for use in cats, was sold in Finland in 2009 [calculated from the Veterinary Medicine sales statistics in Finland (Seppo Taipaleenmäki, Eläinlääketeollisuus ry, Pharma Industry Finland, personal communication)], in addition to numerous other antiparasitics that can be used for cats.

Our aim was to estimate the prevalence of the intestinal parasites in Finnish cats and to identify possible risk factors for the infections. We excluded *Tritrichomonas foetus* and nematode larvae (respiratory parasites) from our study plan owing to the different methodology used for their diagnostics. A pilot anthelmintic resistance test of pyrantel treatment against *Toxocara cati* and a questionnaire survey about anthelmintic treatment practices were included. To our knowledge, no large-scale prevalence data on household cats' intestinal parasites has been previously published from Nordic countries.

Materials and methods

Fecal samples were collected from Finnish pet cats between September 2009 and March 2010. The sampling packages were distributed mainly through veterinary clinics and cat shows. Cat owners were asked to send a sample from one cat from their household and to complete a questionnaire. The fecal samples were mailed on the day that they were collected and after arrival at our laboratory the samples were stored at +4°C until examination within a week of the sampling day. A description of the study population is shown in Table 1.

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Table 1 Description of the study population and number and percentage of the *Toxocara/Toxascaris*-positive cats by the main variables. Confidence intervals (CIs), cross-tabulations and test statistics were computed using OpenEpi software, version 2.3.1

Variable		n total[a]	n positive	%	95% CI	*P*
Age group	0–11 months	86	7	8.14	3.6–15.4	0.251
	12 months and over	331	16	4.83	2.9–7.6	
Sex	Female	221	12	5.43	3.0–9.0	0.983
	Male	201	11	5.47	2.9–9.3	
Neutered	Intact	144	7	4.86	2.2–9.4	0.722
	Neutered	278	16	5.76	3.4–9.0	
Pedigree	Non-purebred	215	22	10.23	6.7–14.8	0.000*
	Purebred	207	1	0.48	0.02–2.4	
City cat	Living in the countryside	86	12	13.95	7.8–22.5	0.000*
	Living in a town/city	334	11	3.29	1.7–5.7	
Outdoor	No outdoor access	160	4	2.50	0.8–5.9	0.033*
	Outdoor access	261	19	7.28	4.6–10.9	
Other cats	One cat in the household	108	8	7.41	3.5–13.6	0.316
	More cats in the household	313	15	4.79	2.8–7.6	
Breeding	No breeding	346	23	6.65	4.4–9.7	0.010*
	Breeder	75	0	0.00	0.0–3.9	
Travel	No travelling abroad	324	21	6.48	4.2–9.6	0.082
	Travelled abroad	98	2	2.04	0.3–6.6	
Food/shop	No commercial food in the diet	5	0	0.00	0.0–45.1	0.755
	Commercial food in the diet	417	23	5.52	3.6–8.0	
Food/home	No home-made food in the diet	326	13	3.99	2.2–6.6	0.025*
	Home-made food in the diet	96	10	10.42	5.4–17.8	
Food/meat	No raw meat in the diet	145	5	3.45	1.3–7.5	0.195
	Raw meat in the diet	277	18	6.50	4.0–9.9	
Residence	Living in the capital city area	162	4	2.47	0.8–5.8	0.024*
	Living outside the capital city area	249	19	7.63	4.8–11.5	
Seen cestoda	Owner has not seen proglottids	345	12	3.48	1.9–5.8	0.000*
	Owner has seen proglottids	68	11	16.18	8.8–26.4	
All		424	23	5.42	3.6–7.9	

[a]All information was not available for all cats
*Statistically significant

A gross examination of all samples was initially performed to assess the presence of cestode proglottids. A passive flotation technique was then used to screen 411 samples for parasite eggs and oocysts. Two grams (±0.05 g) of feces were mixed with saturated solution of magnesium sulfate (specific gravity 1.67). The mixture was sieved through a metallic tea strainer (mesh size 0.9 mm) and poured into a test tube full to the brim. The tube was then covered with a 24 mm × 24 mm cover slip. After 30 min incubation the cover slip was transferred onto a microscope slide together with the top of the liquid and screened microscopically with 100× magnification. If the sample was positive for *Isospora*-type oocysts, the oocysts were measured to differentiate *Toxoplasma*-like organisms from *Isospora* species.

If the sample showed *T cati* eggs, the owner received a new sampling package along with an anthelmintic, Pyrantel embonate (Mirrix; Pfizer Animal Health), for the cat. The owners were asked to send a fecal sample from their cat on the day of medication, give the anthelmintic according to the instructions in the package and send a second sample 2 weeks later. Both samples (4 ± 0.05 g each) were quantitatively analyzed for worm eggs with a McMaster method to test the efficacy of the drug [fecal egg count reduction test (FECRT)].

An aliquot of fecal sample was stored at -20˚C for *Giardia* species screening. *Giardia duodenalis* was examined from 402 samples with a commercial enzyme-linked immunosorbent assay (ELISA) kit (ProSpecT Giardia 96 test), which detects *Giardia* species antigen from feces.

Table 2 Parasite prevalence in the fecal flotation (n = 411) and in *Giardia* species ELISA (n = 402)

Parasite	Positive samples (n)	Prevalence (%)	95% CI
Toxocara cati	22	5.4	3.5–7.9
Toxascaris leonina	1	0.2	0.0–1.2
Taenia species	7	1.7	0.7–3.3
Isospora felis	3	0.7	0.2–2.0
Giardia duodenalis	13	3.2	1.8–5.3

The test was performed according to the manufacturer's instructions. Only strong color reactions were interpreted as positive; 1+ samples according to the manufacturer's color scale were interpreted as negatives. Optical densities were also numerically measured.

In the questionnaire, we asked about the cat's habitat, diet, travelling history, anthelmintic treatments, factors affecting the owner's choice of anthelmintic and sources of information about anthelmintic treatments. Only the answers correctly filled were included in the analyses. The questionnaire is available upon request from the corresponding author.

Confidence intervals (CIs) for the obtained estimates of prevalence were computed using Mid-P exact of OpenEpi software, version 2.3.1. Cross-tabulations and test statistics (χ^2 or Fisher's exact tests) from the same software were used to evaluate unconditional associations prior to the logistic regression analyses with Stata 11.0 (StataCorp, College Station, TX, USA). Differences with *P*-values lower than 0.05 were considered statistically significant.

Results

Intestinal worm eggs were found in 7.1% of the examined samples. *Toxocara cati* eggs were the most common finding and in one sample *Toxascaris leonina* was morphologically identified (Table 2). All the *Toxocara*-infected cats were non-pedigree; the one *Toxascaris*-positive cat was a pedigree. *Taenia* species eggs were found in seven of the samples and *Isospora felis* oocysts in three cats, whilst 13 of the samples were clearly *G duodenalis* positive (Table 2). Mixed infections of *T cati* and *Taenia* species were observed in one cat and protozoans *I felis* and *G duodenalis* in another.

Risk factors were evaluated for *Toxocara/Toxascaris*- and *Giardia*-infected cats only because the number of positive cats for other parasites was small. In the univariate analyses the odds of being *Toxocara/Toxascaris*-positive was 3.1 (95%CI 1.02–9.17) times higher in cats that had access to the outdoors when compared with cats confined to indoors. The best logistic regression model for *Toxocara/Toxascaris* species positivity, with more than two variables, gave odds ratios of 0.04 (0.01–0.34) for purebred versus non-pedigree cats, 2.5 (1.02–6.15) for receiving home-made food versus not and 3.6 (1.16–10.94) for living outside the capital city's vicinity. Purebred cats had 6.2 (1.35–28.16) times higher odds for being *Giardia*-positive when compared with non-pedigree cats. The statistically significant differences between the most important tested variables for *Toxocara/Toxascaris* species infections are presented in Table 1.

The age of *Taenia* species infected cats varied between 7 months and 15 years (median 3.5 years), and four of these seven cats had shed *Taenia* species proglottids earlier (according to the information provided by the owners). Cats that had sometimes been seen shedding *Cestoda* species proglottids earlier, had 5.4 (2.25–12.72) times higher odds of being *Toxocara/Toxascaris*-positive and 7.1 (1.56–32.60) times higher odds of being *Taenia* positive when compared with cats with no reports of the owner seeing proglottids.

Nine of the owners of *Toxocara/Toxascaris*-positive cats closely followed the instructions given in the FECRT sample package and their cats were included in the FECRT study. The egg count of the first sample on the day of medication varied from 25 eggs per gram (epg) to 2400 epg (mean 672 epg). No signs of resistance were detected against pyrantel embonate and the after-medication sample was free of roundworm eggs in all cases.

The number of answers to different questions in the questionnaire varied, as not all the owners answered all the questions. When the frequency of anthelmintic treatments was asked about, 62.4% of the cat owners (n_{total} = 415) reported 2–4 treatments per year. One tenth of the owners gave anthelmintics less than once a year; among these one *T cati* and one *I felis*-positive cat was found (prevalence for both parasites in this rarely treated population is 2.4%). Approximately 62.5% of the city cats and 78.6% of the cats living outside the cities were medicated two or more times per year. The difference was statistically significant (*P* = 0.005).

An equal number of owners (n_{total} = 402) reported changing (52%) and not changing (48%) the anthelmintic preparation between the consecutive medication times.

The most important quality of the anthelmintic was its broad spectrum: 46.5% of the owners (n_{total} = 376) considered this to be the most important factor when choosing the medication. 'Easy administration' also

Table 3 Importance of the different anthelmintic qualities influencing on the cat owner's anthelmintic choice (n_{tot} = 376)

Factor	Number of first positions given (%)
Broad spectrum	175 (46.5)
Easy administration	115 (30.6)
Single dose	49 (13.0)
Side effects	27 (7.2)
Price	10 (2.7)

Table 4 Importance of the different information sources in the parasite and anthelmitic issues according to the cat owners (n_{tot} = 386)

Information source	Number of first positions given (%)
Veterinarian	168 (43.5)
Publications on cats	62 (16.1)
Other cat owners	61 (15.8)
Pharmacy	42 (10.9)
Breeders	33 (8.5)
Advertisements	20 (5.2)

ranked highly, whilst the price of the preparation was not a priority for the cat owners (Table 3).

The top-ranking information source regarding parasites and antiparasitic treatments is the veterinarian; 43.5% of the owners (n_{total} = 386) agreed (Table 4).

Discussion

Herein, we have conducted an investigation into feline intestinal parasite prevalence, infection risk factors and anthelmintic treatments in Finland. We sampled pet cats, not selected patient material; their possible preceding clinical signs are not known. The samples analyzed in this study were evenly distributed regarding gender and pedigree/non-pedigree.

Toxocara cati was, as expected, the most common parasite found and non-pedigree cats were at greatest risk for the presence of *Toxocara* species. Pedigree itself is unlikely to explain this risk; however, the potentially different approaches to management of the pedigree versus non-pedigree cats could play a major role. No significant differences were found in relation to alternate medication strategies. Pedigree cat owners may have a greater awareness of parasites than non-pedigree cat owners as a result of education given by the breeder at the time of purchase. Moreover, many of the pedigree cat owners in this study were breeders themselves.

Toxocara cati is a potential zoonotic agent, which should not be overlooked.[1] Each year in Finland, a couple of hundred diagnostic human samples are generally tested for *Toxocara* species, of which about a dozen are seropositive, typically from children with suggestive symptoms and eosinophilia (Sakari Jokiranta, HUSLAB/Haartman Institute, personal communication). To date, no differentiation is made between *T cati* and *Toxocara canis* infections in humans, but owning a cat was considered to be risk factor for *Toxocara* species seropositivity in children of all income classes.[2]

Taenia species belong to cyclophyllidae cestodes and the eggs are shed to the environment, mainly within the proglottids. In fecal flotation, owing to a low number of free *Taenia* species eggs in feces, false-negative results can be obtained. For the cat owners, *Taenia teaniaeformis* infection becomes evident when actively moving proglottids are seen in the cat's rear or rest area. When proglottids are seen earlier, according to statistical analysis, both *Taenia* species, but also *Toxocara* species infections, are suggested.

Other parasitic infections, such as *Diphyllybothrium latum*, a tapeworm that exists in Finland and can also be found in cats fed with undercooked fish, were not found in this study.

Isospora-type oocysts were not further specified, only measured, but the size corresponded to *I felis* in all cases. Additionally, no *Toxoplasma gondii*-like oocysts were detected in any of the samples.

No *Ancylostoma/Uncinaria* species hookworm eggs were found; in Finnish dogs, *Uncinaria* species prevalence is 2.6%,[3] thus the parasite exists but does not seem to be of importance in Finnish cats. The absence of *Dipylidium caninum* findings was not a surprise; cases in Finland are limited to imported animals and are rarely seen (The Central Laboratory of the Department of Equine and Small Animal Medicine, University of Helsinki, personal communication). It would have been interesting to search for lungworms and *T foetus* from the samples, but this was not done here because of practical issues.

The number of FECRT samples received, and accepted, for analysis was affected by some owners not following the instructions given regarding medications and sampling exactly. No signs of pyrantel inefficacy were shown for *T cati*. This was an expected result, as there are no reports, to our knowledge, of anthelmintic resistance in *T cati*. To our understanding, the efficacy of the anthelmintic treatment given to pet animals is, however, rarely affirmed by after-medication testing. Further research in this field, with larger study groups, is needed.

Giardia species cysts or trophozoites are not easily recognized from native fecal samples. We used an antigenic test (Giardia ProSpect-kit) for diagnosis. The test had previously been evaluated with dog samples to have

100% sensitivity and 96% specificity.[4] The 3.2% prevalence of *G duodenalis*, the *Giardia* species that infects cats, was in agreement with the results from some other recent studies,[5,6] but in a study from Germany, performed with the same commercial kit, the prevalence was 12.6%.[7] In the cats showing clinical signs, however, the prevalence has been reported as over 20%.[8] The risk factor for a *Giardia*-positive test was, contrary to *T cati* results, being a pedigree cat. This was an expected risk factor as catteries and cat shows might serve as sources of infection. Age-related risk for *G duodenalis* infection was not observed here, contrary to a recent Romanian study.[9]

We did not genetically analyze the *G duodenalis* assemblages, so no conclusions regarding the potential risk of these *Giardia*-secreting cats to humans can be given. In a Finnish study of canine *Giardia* species infections, 8/150 dogs (5%) were found to be infected and none of the isolates represented a zoonotic genotype.[4] Zoonotic genotypes have been found internationally in cats, as reviewed by Ballweber et al.[10]

Our prevalence results are quite similar to a German study of 8560 cats,[7] but differ from a study of 414 household cats from Romania,[11] in which the overall endoparasite prevalence was as high as 34.3% and *T cati* prevalence 20.3%. The anthelmintic treatment practices in Romania differed between urban areas, where anthelmintics were commonly (87.3%) administered four times per year, and rural areas, where only one treatment per year was the pattern (12.7%). In our data, however, city cats were treated less often than countryside cats. For *Toxocara* species infections, risk factors were somewhat similar in both studies, but age-related risk was not seen in our material; age as a continuous variable and as a dichotomous variable (age groups: 0–11 months and over 11 months) was not significant in any of the analyses. The explanation for that could be in more efficient anthelmintic treatments of kittens than adults, and lower infection pressure from prey to kittens. In a study from the UK,[12] *Toxocara* species prevalence in healthy kittens (n = 57) was 15.7%. Also, five kittens that were claimed to have an anthelmintic administered were positive and the difference in prevalence between the medicated kittens and the ones that had not received anthelmintic was not significant[12]. It seems that the kittens in our study population were more efficiently dewormed.

Many parasitic infections are subclinical in adult cats, but may cause severe clinical signs in kittens. In a cattery, infections can spread quickly and may be difficult to eradicate. Regular fecal examination for worm eggs or an appropriate anthelmintic treatment should be performed for the cats according to their risk profile. In addition, protozoan parasites should be kept in mind when dealing with a cat diarrhea, or even in asymptomatic cats with a cat show history and a cattery living environment.

The frequency of anthelmintic treatments was quite high in this study material but, at the same time, about 10% of the cats did not receive anthelmintics, even yearly. Because parasite prevalence in the rarely treated group was low, these cats supposedly also had a low risk for infections. Cats are small in size and the price of the treatment is not a large burden for the owners, as it can be when large-breed dogs are treated. Similar to the earlier canine study,[3] a broad spectrum was also the most important quality of the anthelmintic to the cat owners. The explanation is simple: owners want to eliminate all possible infections at the same time because the medication is not based on diagnosis. Knowledge about the risk factors provided, for example, in this study and parasites in general might adjust the medication choices to be more specific. At the same time, anthelmintic resistance of pet parasites should be closely monitored. It is important that veterinarians, regarded as the most important information source, adopt and maintain an active, educative attitude on spreading updated information about parasites to their clients.

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