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Prevalence of intestinal parasites in private-household cats in Japan

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Abstract

The present study is the first national investigation of intestinal parasites in private-household cats in Japan. A total of 942 faecal samples were collected from private-household cats. *Giardia* species was assessed using an enzyme-linked immunosorbent assay kit and other intestinal parasites were identified microscopically. The overall prevalence of intestinal parasites was 10.1%; two protozoan parasites (*Giardia* species and *Cystoisospora* species) and five helminths (*Toxocara cati, Toxascaris leonina, Ancylostoma tubaeforme, Taenia* species and *Spirometra erinacei*) were detected. The total prevalence of intestinal parasite infection was significantly higher in cats aged ≤6 months old than in cats older than 6 months because of a significantly higher prevalence of *Cystoisospora* species and *T cati*. The total infection prevalence was higher among outdoor cats as a result of the significantly higher prevalence of *T cati* and *S erinacei*. Sex and faecal condition were not related to intestinal parasite infections. Regional differences were observed in *Cystoisospora* species and *A tubaeforme*.

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Cats clearly offer significant benefits to modern human society.[1,2] However, there are well-documented health hazards associated with cat ownership.[3,4] For instance, some of the intestinal parasites carried by cats can be transmitted to humans.[5,6] *Toxocara cati* can induce visceral and ocular larva migrans in humans who accidentally ingest embryonated infective eggs from environmental contamination or who eat tissues from paratenic hosts, such as the raw livers of domestic animals.[7,8] In addition, the zoonotic transmission of *Giardia* species from cats to humans must be considered because cats can carry genotypes (assemblages A and B) that are potentially infectious to humans.[6,9] In addition to zoonotic disease in humans, intestinal parasites can induce digestive tract obstruction in host cats.[10]

Considering the above-mentioned background and the recent status of close contact between humans and cats, information on intestinal parasites carried by private-household cats (not stray cats) is clearly significant for the welfare of both cats and humans. Nevertheless, in the past 10 years there has only been one published report concerning a survey of intestinal parasites in private-household cats in Japan,[11] and this survey was performed in a limited local area. The present report, therefore, represents the first description of a large-scale, national survey of intestinal parasites in private-household cats that presented to several regional veterinary clinics in Japan.

A total of 942 fresh faecal samples were collected randomly from private-household cats (aged from 1 month to 22 years), with or without a history of illness, that presented to 17 veterinary clinics located in different regions of Japan (Hokkaido: one clinic; Tohoku: seven clinics; Kanto: four clinics; Kinki: two clinics; Kyushu: two clinics; Okinawa: one clinic) between January 2008 and October 2011. All faecal samples were donated by the cat owners, who granted permission to include their cats in the survey. The samples were collected immediately after natural defecation and were stored at 4°C until examination (within 3 days). The presence of a *Giardia*-specific antigen in stool was assessed using an

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Table 1 Prevalence of intestinal parasites in private-household cats which visited veterinary clinics in Japan

Parasite	Overall (n = 942)	Age categories: ≤6-month-old cats (n = 228)	Age categories: >6-month-old cats (n = 714)	Age categories: *P*-value	Lifestyles: Indoor (n = 804)	Lifestyles: Outdoor (n = 138)	Lifestyles: *P*-value	Sex: Male (n = 498)	Sex: Female (n = 444)	Sex: *P*-value	Faecal conditions: Formed (n = 897)	Faecal conditions: Unformed (n = 45)	Faecal conditions: *P*-value
Giardia species	1.5% (14)*	3.1% (7)	1.0% (7)	NS	1.5% (12)	1.4% (2)	NS	2.0% (10)	0.9% (4)	NS	1.6% (14)	0% (0)	NS
Cystoisospora species	1.4% (13)	4.8% (11)	0.3% (2)	<0.0001	1.1% (9)	2.9% (4)	NS	1.6% (8)	1.1% (5)	NS	1.2% (11)	4.4% (2)	NS
Cystoisospora felis	0.5% (5)	2.2% (5)	0% (0)	<0.001	0.4% (3)	1.4% (2)	NS	0.4% (2)	0.7% (3)	NS	0.4%(4)	2.2%(1)	NS
Cystoisospora rivolta	1.0% (9)	3.1% (7)	0.3% (2)	<0.001	0.9% (7)	1.4% (2)	NS	1.2% (6)	0.7% (3)	NS	0.9%(8)	2.2%(1)	NS
Toxocara cati	6.2% (58)	15.4% (35)	3.2% (23)	<0.0001	4.9% (39)	13.8% (19)	<0.001	6.2% (31)	6.1% (27)	NS	6.4% (57)	2.2% (1)	NS
Toxascaris leonina	0.2% (2)	0.4% (1)	0.1% (1)	NS	0.2% (2)	0% (0)	NS	0.4% (2)	0% (0)	NS	0.2% (2)	0% (0)	NS
Ancylostoma tubaeforme	0.5% (5)	0.9% (2)	0.4% (2)	NS	0.5% (4)	0.7% (1)	NS	0.6% (3)	0.5% (2)	NS	0.6% (5)	0% (0)	NS
Taenia species	0.3% (3)	0.4% (1)	0.3% (2)	NS	0.4% (3)	0% (0)	NS	0.4% (2)	0.2% (1)	NS	0.3% (3)	0% (0)	NS
Spirometra erinacei	1.7% (16)	1.3% (3)	1.8% (13)	NS	1.0% (8)	5.8% (8)	<0.001	2.0% (10)	1.4% (6)	NS	1.8% (16)	0% (0)	NS
Total infection	10.1% (95†)	22.4% (51†)	6.2% (44†)	<0.001	8.5% (68†)	19.6% (27†)	<0.001	10.8% (54†)	9.2% (41†)	NS	10.3% (92†)	6.7% (3)	NS

*Number of infected cats
†This total number is smaller than sum of each parasite because of multiple infections
NS = not significant

Table 2 Multiple infections of intestinal parasites in 14 private-household cats in Japan

Parasite	Positive samples
Giardia species + *Toxocara cati*	1
Giardia species + *Toxascaris leonina*	1
Giardia species + *Sprometra erinacei*	1
Cystoisospora species + *Toxocara cati*	3
Cystoisospora species + *Toxocara cati* + *Ancylostoma tubaeforme* + *Spirometra erinace*	1
Toxocara cati + *Ancylostoma tubaeforme*	1
Toxocara cati + *Sprometra erinacei*	5
Taenia species + *Sprometra erinacei*	1

enzyme-linked immunosorbent assay kit (Snap *Giardia*; Idexx Laboratories) following the manufacturer's instructions. Other intestinal parasites were identified microscopically using the formalin-ethyl acetate sedimentation technique.[12] Briefly, a well-mixed faecal suspension composed of approximately 1.0 g of stool sample and 10 ml of distilled water was filtered through two layers of gauze into a centrifuge tube and centrifuged for 2 min at 500 × *g*. After the supernatant was decanted, 9 ml of 10% formalin was added to tube and thoroughly mixed with the sediment. Then, 4 ml of ethyl acetate (instead of diethyl ether because diethyl ether is flammable and explosive) was added. The tube was capped, shaken for 30 s and centrifuged for 2 min at 500 × *g*. The centrifuged specimen contained four layers (a top layer composed of primarily ethyl acetate, an interface of fatty faecal debris, a lower formalin layer and sediment). The upper layers were removed, leaving the sediment undisturbed. The sediment was re-suspended with one drop of 10% formalin and examined under a microscope. The data were analysed according to age category (≤6-month-old cats vs >6-month-old cats), lifestyle (indoor: staying inside the house for more than 70% of the day vs outdoor: staying inside for less than 70% of the day), sex (male vs female), faecal condition (formed vs unformed) and veterinary clinic location (Hokkaido and Tohoku in the northern region of the country with a cold climate; Kanto in the eastern region with a more temperate climate; Kinki and Kyushu in the western region with a warmer climate; and Okinawa in the southern region with a subtropical climate). Unfortunately, history of anthelmintic treatments was unknown. Fisher's exact probability test was used to compare the data, and values of P <0.05 were considered significant.

Of the 942 private-household cats, 10.1% (95 cats) were positive for at least one species of intestinal parasite (see Table 1). Two protozoan parasites (*Giardia* species and *Cystoisospora* species) and five helminths (*Toxocara cati*, *Toxascaris leonina*, *Ancylostoma tubaeforme*,

Table 3 Prevalence of intestinal parasites in private-household cats from different regions in Japan

Parasite	Hokkaido (n = 27)	Tohoku (n = 520)	Kanto (n = 138)	Kinki (n = 62)	Kyushu (n = 121)	Okinawa (n = 74)
Giardia species	3.7% (1)*	1.2% (6)	3.6% (5)	0% (0)	1.7% (2)	0% (0)
Cystoisospora species	0% (0)	0.6%‡ (3)	0% (0)	4.8% (3)	4.1%§ (5)	2.7% (2)
Cystoisospora felis	0% (0)	0.2% (1)	0% (0)	1.6% (1)	1.7% (2)	1.4% (1)
Cystoisospora rivolta	0% (0)	0.4%¶ (2)	0% (0)	3.2% (2)	3.3%∞ (4)	1.4% (1)
Toxascaris leonina	0% (0)	0.2% (1)	0.7% (1)	0% (0)	0% (0)	0% (0)
Ancylostoma tubaeforme	0% (0)	0.4%# (2)	0% (0)	0% (0)	0% (0)	4.1%** (3)
Taenia species	0% (0)	0.4% (2)	0% (0)	0% (0)	0% (0)	1.4% (1)
Spirometra erinacei	0% (0)	2.5% (13)	0.7% (1)	0% (0)	0.8% (1)	1.4% (1)
Total infection	11.1% (3)	10.8% (56†)	6.5% (9†)	9.7% (6)	10.7% (13†)	10.8% (8†)

*Number of infected cats
†This total number is smaller than sum of each parasite because of multiple infections
‡vs §: $P<0.01$
¶vs ∞ and # vs **: $P<0.05$

Taenia species and *Spirometra erinacei*) were detected. Multiple infections were present in 14 cats (see Table 2). The most common multiple infections were combinations of *T cati* plus other parasites. The analysis based on age category revealed that the total prevalence of intestinal parasite infection was significantly higher in cats ≤6 months old than in those >6 months old. The prevalence of *Cystoisospora* species (both *Cystoisospora felis* and *Cystoisospora rivolta*) and *T cati* in ≤6-month-old cats was significantly higher than in >6-month-old cats. No significant differences related to the age category were observed for the other parasites. The total prevalence of all infections for outdoor cats was significantly higher than for indoor cats. Additionally, the prevalence of *T cati* and *S erinacei* was significantly higher in outdoor cats. Sex and faecal condition were not related to intestinal parasite infections. There was no significant difference in the total infection prevalence among regions (see Table 3). However, significant regional differences were found between Tohoku and Kyushu with respect to *Cystoisospora* species infections, and between Tohoku and Okinawa with respect to *A tubaeforme* infections.

The present investigation is the first study to determine the national prevalence of intestinal parasites among private-household cats that presented to veterinary clinics in various regions in Japan. The overall prevalence of intestinal parasites was 10.1% in the present study. Recently, a few reports have been published regarding the prevalence of intestinal parasites in private-household (not stray) cats in developed countries.[13–15] An approximate prevalence of 15–20% was reported in Australia,[13] the USA[14] and Germany.[15] It is difficult to compare the levels of parasitism between these studies and ours because of the different methods of faecal examination and cat populations used. However, it is clear that intestinal parasites are not rare in private-household cats, although owners' knowledge about parasites is likely to be sufficiently higher in developed countries. The prevalence of *Cystoisospora* species (both *C felis and C rivolta*) and *T cati* were significantly higher in cats under the age of 6 months. *Cystoisospora* species infection in cats is usually only observed in naturally-infected kittens, and it is suggested that cats develop life-long immunity to coccidian parasites, but this immunity is not complete.[14,16] *Toxocara cati* also contributed considerably to the higher total infection rate in cats under the age of 6 months. Although cats can acquire patent infection with *T cati* at any age,[8,17] transmammary infection plays an important role in kittens.[8] The analysis of the data based on lifestyle revealed that the total infection prevalence was higher among outdoor cats owing to the significantly higher prevalence of *T cati* and *S erinacei*. The spread of *T cati* infection via environmental contamination[8,17] is the factor that is most likely responsible for the higher prevalence of *T cati* in outdoor cats. Similar to *T cati* infection, *S erinacei* infection is established by the ingestion of second intermediate hosts, such as frogs.[18] Considering the epidemiological patterns of the parasitosis, outdoor animals have more opportunities to become infected.[10] Because of the higher likelihood of exposure for outdoor cats, the control of recurrent *T cati* and *S erinacei* infections in outdoor cats would likely be difficult. The harbouring of intestinal parasites had no effect on the faecal condition. Although intestinal parasites have the potential to induce intestinal disorders in cats,[10] diarrhoea associated with the presence of intestinal parasites does not occur in every case.[6,10] Cats that are positive for intestinal parasites and develop no clinical signs play an important role in the transmission of zoonotic parasites because these cats serve as carriers;

carriers that do not exhibit changes in faecal condition are less likely to undergo deworming owing to a lack of recognition of the infection by their owners. These untreated cats continue to shed pathogens into the environment. Regional differences were found for several intestinal parasites. There was a regional difference in *Cystoisospora* species infection between Tohoku and Kyushu. Cats in the ≤6-month-old groups were more common in Kyushu (57.9%; 70/121) than in Tohoku (35.4%; 184/520); these young cats had an increased prevalence of *Cystoisospora* species infection.[14,16] The prevalence of *A tubaeforme* was higher in Okinawa than in Tohoku. The difference in the climate between these regions is likely to be a major reason for this difference in prevalence.[6] For transmission to occur, hookworms need to develop into infective larvae in the soil from eggs passed in the host's stool.[6] Higher temperature and humidity (tropical and subtropical climates) provide an adequate environment for this growth stage.[6] Okinawa is located in the southernmost region of Japan and has a subtropical climate, whereas Tohoku is located in the northern region and experiences subfreezing temperatures in the winter.

The present study demonstrated that the prevalence of intestinal parasites in private-household cats in Japan was high among cats younger than 6 months and outdoor cats. Further careful investigations of the intestinal parasites carried by cats are recommended to prevent zoonotic transmission from cats to humans.

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