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A survey on endoparasites and ectoparasites of stray cats from Mashhad (Iran) and association with risk factors

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Abstract As there appeared to be no data available on parasite infection of stray cats in the region and considering the potential threat of stray cats for animal and public health, the present study was carried out using biological samples and necropsy finding collected from cats captured in Mashhad city in the northeast of Iran. From a total 52 stray cats examined, 18 (34.6%) were male and 34 (65.4%) were female. Ten species of endoparasites including helminthes and protozoa and two species of ectoparasites were detected in the examined cats. There were two protozoa, five cestodes, three nematodes and two arthropods. Overall 46 cats (88.46%) have been infected with at least one of the parasites. The following parasites, with their respective prevalence, were found; Nematoda: *Toxocara cati* 28.84%, *Toxocara leonina* 7.69%, *Physaloptera praeputialis* 3.84%; Cestoda: *Dipylidium caninum* 23.08%, *Mesocestoides lineatus* 13.46%, *Taenia taeniaformis* 9.6%, *Joyeuxiella echinorhyncoides* 7.6% and *Taenia hydatigena* 1.92%; Protozoa: *I. felis* 23.7%, *Haemobartonella felis* 1.92%; Arthropoda: *Ctenocephalides felis 1*.92% and *Cheyletiella blakei* 1.92%. Based on our data, there was no significant difference in infection rate between male and female animals. However, the age of the cats were found to be an important risk factor associated with parasitic infection. Our results revealed that zoonotic agents, namely *T. cati* were present in stray cat colonies in the investigated area. In this respect, appropriate control measures should be taken and it is recommended to determine the most appropriate preventive methods.

Keywords Parasites · Prevalence · Stray cat · Risk factor · Mashhad

Introduction

Stray cat populations are important as the potential reservoir hosts of a variety of parasites in medical and veterinary point of view. The importance of controlling the size of these populations and the most appropriate methods to achieve this purpose is a controversial issue of concern for municipalities and animal protection associations.

Amongst zoonotic agents transmitted by cats, *Toxoplasma gondii* and *Toxocara cati* are among the most important feline gastrointestinal parasites (Robertson and Thompson 2002). Additionally, in Iran and southern European countries, the cat has been identified as a reservoir for *Leishmania infantum* (Hatam et al. 2010; Cardoso et al. 2010). Many non-zoonotic infectious agents are also important in cats. Parasites such as *Isospora* and *Otodectes* species cause diarrhea and otitis.

In Iran, cats are often reared at homes as a pet and or exploited as a predator of rats. However, many of them become stray cats as the result of changes in housing patterns. These cats live freely in urban and rural areas, and tend to discharge helminth eggs, larvae and protozoan cysts into the general environment (Jamshidi et al. 2002; Bahadori et al. 2004; Sharif et al. 2007; Zibaei et al. 2007; Arabali and Hooshyar 2009). Most surveys of feline parasites conducted in the past have been limited to feral cats (Okaeme 1986; Milstein and Goldsmid 1997; Barutzki and Schaper 2003; McGlade et al. 2003; Palmer et al. 2008;

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Gates and Nolan 2009) and have been carried out in order to identify the significance of feral cats as potential reservoirs of infection (Calvete et al. 1998). There have been few detailed and comprehensive studies of the prevalence of parasites in stray cats and there is little information on the level of parasitic infection in stray cats with various parasites (Zibaei et al. 2007; Arabali and Hooshyar 2009; Kreceka et al. 2010). The importance of controlling feline parasites is not only to relieve clinical symptoms in infected cats, but also to minimize the zoonotic potential of larval parasitic infection in human.

Since cats constitute a potential source of infection in human (Markell et al. 2006), the aim of the present study is to determine the prevalence and risk factors of infection of parasites in stray cats of Mashhad, Northeast of Iran.

Materials and methods

Mashhad lies in northeast of Iran with a human population almost 2.5 million. This city is the second largest holy city in the world which attracts more than 20 million tourists and pilgrims every year. This area is located at 36.20° latitude and 59.35° east longitude, in the valley of the Kashaf River near Turkmenistan, between the two mountain ranges of Binalood and Hezar-masjed. The city benefits from the proximity of the mountains, having cool winters, pleasant springs, mild summers, and beautiful autumns. The city only sees about 250 mm of precipitation per year, some of which occasionally falls in the form of snow. Mashhad also has wetter and drier periods with the bulk of the annual precipitation falling between the months of December and May.

This study was performed based on cross sectional design. Fifty-two stray cats were trapped and collected from different residential areas of Mashhad between October 2009 and September 2010 with permission from appropriate authorities from the Iranian Environmental Health Organization. Trapping using baited cage-traps with tinned fish was undertaken in the city of Mashhad.

The animals were identified and registered in a data form registering all available information of each one. All the cats were anaesthetized by intra muscular injection of high doses of anesthetic drug (Ketamine 10%) and then were humanely euthanatized by chloroform. Their carcasses were autopsied not later than 1 h after killing and examined for the presence of protozoa, helminthes and ectoparasites. The animals were examined for ectoparasite infestation by a body search, and the whole body was combed with a stainless steel fine-toothed flea comb (Zakson et al. 1995). Ticks were manually removed and collected together with any fleas and lice in the comb. After post-mortem examination, the abdominal cavity was opened and the internal organs including stomach, intestine, kidney, liver, heart and lungs were removed. The small intestine was opened longitudinally with a pair of scissors in 0.85% saline and washed with the same solution until the supernatant had cleared. The mucous was scraped between the blades of a forceps and the contents with epithelial scrapings passed and washed with tap water on a 40- and 60- mesh per inch brass sieves. The filtrate retained in the sieve was washed into a glass container and examined carefully for helminthes parasites.

The contents of the gastrointestinal tract were then carefully assessed with the naked eyes as well as under a stereomicroscope. All helminthes recovered, including nematodes were fixed in 10% formalin cleared in lactophenol and stained with acetocarmine and measured using a micrometer. The identification was carried through following the key of Yamaguti (1961) and Soulsby (1977).

Feline fresh fecal samples were examined for cyst and trophozoite of protozoa, egg and larva of helminthes by direct and formalin-ether sedimentation technique followed by microscopy. Also, blood samples of these stray cats were analysed for haemoprotozoa by smear examination of blood stained with Giemsa's stain.

The prevalence and confidence intervals (CI) were calculated for each parasite. Associations between parasitism and host characterizes were made using the Chi-square and Fisher exact test and their 95% confidence intervals. Data was analyzed and statistical comparisons were performed using SPSS 16.0.

Result

Of the 52 stray cats included in the investigation, 18 (34.6%) were male and 34 (65.4%) were female. Ten species of endoparasite including helminthes and protozoa and two ectoparasites were detected in the examined cats. There were two protozoa, five cestodes, three nematodes and two arthropods. Overall 46 cats (88.46%) have been infected with at least one of the parasites.

Prevalence of parasites was: Phylum Nematoda: *T. cati* 28.8%, *Toxocara leonina* 7.6% and *Physaloptera praeputialis* 3.8%. Class Cestoda: *Dipylidium caninum* 23.07% *Mesocestoides lineatus* 13.4%, *Taenia taeniaformis* 9.6%, *Joyeuxiella echinorhyncoides* 7.6% and *Taenia hydatigena* 1.9%, Phylum Protozoa: *Isospora felis* 23.7%, *Haemobartonella felis* 1.92%, Phylum Artropods: *Ctenocephalides felis* 1.92% and *Cheyletiella blakei*1.92% (Table 1). Based on our data, there was no significant difference in infection rate between male and female animals. However, the age of the cats were found to be an important risk factor associated with parasitic infection and cats less than

Table 1 Prevalence of parasites found in 52 stray cats kept at Mashhad city, Iran

Parasites	Species	Prevalence (95% CI)
Nematodes	*Toxocara cati*	28.8 (16.7–40.9)
	Toxoascaris leonina	7.6 (0.4–14.8)
	Physaloptera praeputialis	3.8 (1.3–8.9)
Cestodes	*Dipylidium caninum*	23 (12–34)
	Mesocestoides lineatus	13.4 (4.2–22.6)
	Taenia taeniaeformis	9.6 (1.6–17.6)
	Joyexiella echinorhyncoides	7.6 (0.5–14.7)
	Taenia hydatigena	1.9 (1.8–5.6)
Protozoa	*Isospora felis*	23.7 (12.2–35.2)
	Haemobartonell felis	1.9 (1.8–5.6)
Arthropods	*Ctenocephalides felis*	1.9 (1.8–5.6)
	Cheyletiella blakei	1.9 (1.8–5.6)

6 months old being more likely to be infected with *T. cati* and *I. felis* than older cats (Table 2).

Discussion

The zoonotic character of some parasites found in this study must serve as an alert to public health agencies, veterinarians and pet owners, especially when data from approximately 40 years ago (Langenegger and Lanzieri 1963) show that cats, although infected in different intensities, are still parasitized by the same species despite of the availability of new chemoprophilatic protocols. Veterinarians in practice are often the best and only source of information about zoonoses for pet owners.

In this study, *T. cati* was the most frequent species of helminth (28.8%). Similar prevalence of infection of *T. cati* have been recorded in other region of Iran (Sadjjadi et al. 1998; Jamshidi et al. 2002; Bahadori et al. 2004; Zibaei et al. 2007; Arabali and Hooshyar 2009).In addition, there are several reports from other countries of the world which reported prevalence of 3–85% (Overgaauw 1997; Calvete et al. 1998; Barutzki and Schaper 2003; Sommerfelt et al. 2006; Palmer et al. 2008; Mircean et al. 2010) with higher prevalence reported in kittens (Visco et al. 1978). Moreover, *D. caninum* was another most frequent species of helminth, which requires fleas as intermediate hosts. Cats get infected after ingesting infected fleas. On the other hand, only few stray cats in this study were infected with other gastrointestinal helminth e.g. *P. praeputialis*, *T. taeniaeformis, T. hydatigena, J. echinorhyncoides* and *M. lineatus* probably a reflection of these cats were eating few the intermediate hosts. Scarce information is available on the prevalence of these helminthes in Iran (Zibaei et al. 2007; Arabali and Hooshyar 2009). Aside from intermittent vomiting in some infected cats with *P. praeputialis*, these parasites are relatively harmless.

There was no significant difference in infection rate between male and female animals. However, with regard to age, it seems that older animals are more prone to acquire the infection. The present study confirms the findings of other studies (Jamshidi et al. 2002; Bahadori et al. 2004; Arabali and Hooshyar 2009) which reported no difference in the intensity of infection in male and female cats. Sex seemed to have no effect on prevalence of parasitism, and the only effect of neutering was on the occurrence of ascarid infection. The age of the cat was found to be an important risk factor associated with parasitic infection,

Table 2 Prevalence of parasites in relation to age and sex of the cats ($n = 52$)

Parasite	Prevalence, total (%)					
	Age		Significance (χ^2; P)	Sex		Significance (χ^2; P)
	≤6 month ($n = 18$)	>6 month ($n = 34$)		Male ($n = 18$)	Female ($n = 34$)	
Toxocara cati	11 (61.1)	4 (11.7)	<0.001	5 (27.7)	7 (20.5)	>0.001
Toxoascaris leonina	3 (16.6)	1 (2.9)	>0.001	2 (11.1)	2 (5.8)	>0.001
Physaloptera praeputialis	0	2 (5.8)	>0.001	0	2 (5.8)	>0.001
Dipylidium caninum	3 (16.6)	9 (26.4)	>0.001	5 (27.7)	7 (20.5)	>0.001
Mesocestoides linaetus	0	7 (20.5)	>0.001	3 (16.6)	4 (11.7)	>0.001
Joyexiella echonorhyncoides	0	4 (11.7)	>0.001	1 (5.5)	3 (8.8)	>0.001
Taenia taeniaeformis	0	5 (14.7)	>0.001	1 (5.5)	4 (11.7)	>0.001
Taenia hydatigena	0	1 (2.9)	>0.001	1 (5.5)	0	>0.001
Isospora felis	13 (72.2)	0	<0.001	6 (33.3)	7 (20.5)	>0.001
Haemobartonella felis	0	1 (2.9)	>0.001	0	1 (2.9)	>0.001
Ctenocephalides felis	0	1 (2.9)	>0.001	1 (5.5)	0	>0.001
Cheyletiella blakei	0	1 (2.9)	>0.001	1 (5.5)	0	>0.001

with cats less than 6 months old being more likely to be parasitized than older cats. These findings are similar to those obtained in previous studies (Visco et al. 1978; Wilson-Hanson and Prescott 1982; Shaw et al. 1983; Nolan and Smith 1995; Hill et al. 2000; Spain et al. 2001; Barutzki and Schaper 2003; Palmer et al. 2008; Gates and Nolan 2009; Mircean et al. 2010). It is probable that infection can occur at any age, either by eggs or tissue containing the larvae, although the highest incidence of infection occurs in kittens and young cats. It is important to remind the reader that high prevalence of *T. cati* in kittens as due to the transmammary route of infection. OLorcain (1994) showed that intra-uterine infection seldom occurs and that *T. cati* infection mostly results from the ingestion of infective eggs, earth worms, cockroaches or rodents containing larvae in their tissues. However, there are many stray cats in the various residential areas of Mashhad city as well as other cities in Iran where the cat population rapidly increasing in these urban sites. This can significantly contribute to the dissemination of viable helminthes eggs into the environment, and a mild, temperate climate appears to enhance the embryonation of helminthes eggs in the soil and their potential transmission to humans.

In addition, examination of fresh fecal samples obtained during the study revealed the presence of *I. felis* in 23.7% of stray cats which was the most prevalent protozoa in this study. However, low prevalence of infection with *I. felis* reported previously (Arabali and Hooshyar 2009). *I. felis* have worldwide distribution, and infections are very common, particularly in young animals (Palmer et al. 2008; Lappin 2010). In the US, the infection in cats can vary from 3 to >30% (www.capcvet.org) Based on our data, gender do not influence the *I. felis* shedding rates, but young animals are more likely to be shedding oocysts than adults significantly. Similar to other studies from southern region of Iran, only few stray cats in blood smear examination were infected with *H. felis* (Shoorijeh et al. 1999). In spite of few reports of *Giardia spp*. in stray cats in other region of Iran (Arabali and Hooshyar 2009), we have found no infection with *Giardia* in fresh fecal samples. However, high prevalence of enteric protozoa reported in domestic cats from other region of the world (Barutzki and Schaper 2003; McGlade et al. 2003; Gates and Nolan 2009). It is possible that protozoa may not have been detected or were under-diagnosed in earlier studies because the diagnostic techniques used were not sensitive enough to detect low levels of protozoa. When fecal sample is collected only, prepatent infection in cats as well as intermittent shedding of parasite stages may lead to the underestimation of the prevalence of parasitic infections (Sherding 1983). In veterinary practice, the importance of PCR must be considered in terms of the practicality and cost effectiveness of using such a technique for routine diagnosis.

In the stray cats from Mashhad, two species of ectoparasites (*C. felis* and *C. blakei*) were identified. In many areas of the world, *C. felis* is considered the most common external parasites infesting cats (Lisa et al. 2002; Dashamir et al. 2009; Kreceka et al. 2010). Infestation with this ectoparasite can cause in considerable discomfort and dermatological reactions as it affects their hosts directly by feeding blood and cause dermatitis and other allergic reactions. Moreover, *C. blakei*, an ectoparasitic mite of domestic cats, can cause an extremely annoying, persistent and pruritic dermatosis of obscure origin (cryptic infestation) in susceptible persons having close contact with infested cats (Keh et al. 1987). In contrast to the infection with gastrointestinal parasites, the ectoparasite fauna of stray cats in Iran is much less well documented. Not surprisingly, no ticks were found on the cats. To the best of our knowledge, there is no specific data regarding infestation of cats with ticks from Iran. However, infestation of cats by *Ixodes ricinus, Ixodes hexagonus, Ixodes canisuga, Ixodes scapularis, Amblyomma americanum, Dermacentor variabilis* and *Rhipicephalus sanguineus* is reported from other countries of the world(Akucewich et al. 2002; Nijhof et al. 2007; Xhaxhiu et al. 2009; Mendes-de-Almeida et al. 2010).

Stray cats in Mashhad were infected by various parasites. It is clear that the worldwide distribution of stray cats would have an impact on sanitation and it is necessary that public health authorities and veterinarians in crowed centers pay more attention to this phenomenon, and that the general public is informed of the hazards and zoonotic aspects of parasites, especially as female worms can lay many eggs per day.

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