An epidemiological survey on intestinal helminths of stray dogs in Mashhad, North-east of Iran

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Abstract This research was conducted to determine the prevalence of gastrointestinal helminths in stray dogs in the northeast of Iran, with special attention to those parasites that can be transmitted to human. In this experiment, a total of 72 adult and 18 juvenile stray dogs were collected and necropsied for the presence of helminth parasites from October 2011 to August 2012. The overall prevalence of gastrointestinal helminths was 86 % (95 % CI: 79.2–92.8 %). The observed helminths of the gastrointestinal tract were listed as follows: *Toxocara canis* (29 %), *Toxascaris leonina* (7 %), *Ancylostoma caninum* (2 %), *Taenia hydatigena* (43 %), *Dipylidium caninum* (39 %), *Echinococcus granulosus* (38 %), *Mesocostoides lineatus* (16 %), *Taenia multiceps* (11 %), *Taenia ovis* (3 %). There were no significant differences for the prevalence of gastrointestinal helminths between female (83.6 %) and male (89.7 %) and between young (89 %) and adult (72.2 %) animals. However, the prevalence of *E. granulosus*, *T. hydatigena* and *D. caninum* showed an increasing trend with increasing host age, significantly. Based on our data, it is important to point out the presence of zoonotic agents, namely *E. granulosus* and *T. canis* in stray dogs in the investigated area. Due to its impact on public health, appropriate control measures should be taken and it is recommended to determine the most appropriate preventive methods.

Keywords Intestinal helminths · Prevalence · Stray dogs · Northeast of Iran

Introduction

The role of dogs as companion animals and the close relationship between humans and dogs, although offering significant benefits to many people, also represent a potential public health risk. Although the stray dogs are usually disgusted in Iran due to religious believes, sanitary reasons and their biting nature, but still they comprise the largest population of zoonotic reservoirs in the country.

Considering aspects related to public and animal health, study of the prevalence of parasite infections in dogs should, therefore, be a continuous task, with the most relevant aim being the establishment of control measures. Numerous studies have been conducted on the prevalence of the gastrointestinal helminths of stray dogs from areas all over the world including Iran (Dalimi et al. 2006; Fontanarrosa et al. 2006; Razmi et al. 2006; Martínez-Moreno et al. 2007; Eslami et al. 2010; Shalaby et al. 2010; Bajera et al. 2011; Xhaxhiu et al. 2011). However, current information on regional prevalence is essential for development and modification of control measures in animal and public health. Based on the above considerations, the objective of the present study was to determine the prevalence of gastrointestinal helminths in stray dogs in Mashhad, North-east of Iran, with especial attention to potential zoonotic diseases based on their autopsy data.

Materials and methods

Study area

This study was conducted in Mashhad County, the capital of Razavi Khorasan Province, which located in the

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northeastern part of Iran (Fig. 1). It has an area about 27,480 km² and a population of ~2500,000 and is located at 36.20° North latitude and 59.35° East longitudes, in the valley of the Kashaf River near Afghanistan on the east and Turkmenistan by the north, between the two mountain ranges of Binalood and Hezar-masjed. The city only sees about 250 mm of precipitation per year, some of which occasionally falls in the form of snow. Annual precipitation falling usually occurs between the months of December and May.

Animals

From October 2011 to August 2012, 100 stray dogs were collected randomly from different regions of Mashhad County. The animals' collected were either dead or humanely euthanatized by chloroform in the course of study with permission from appropriate authorities from the Iranian Environmental Health Organization. In order to evaluate the role of the different risk factors for infection, sex and age of these dogs was recorded in a sheet.

Parasitological procedures

Following autopsy of the animals, observation for enteric parasites was carefully done. The cranial end of the oesophagus and the end of the rectum were tied off for removing the entire gastrointestinal tract. The gastrointestinal tract was opened for a thorough examination. Contents were flushed out with saline solution, and the resulting solution was observed. Macroscopical and microscopical analysis of the mucosa was done, examining the digestive content and scrapings of the mucosa. Recovered helminths were fixed in alcohol and the cestodes were stained with carmine. The parasites were identified according to the keys and guideline given by Yamaguti (1961).

Data analysis

Prevalence and 95 % confidence interval for infection were calculated as the number of parasitologically positive animals divided by the total number of animals observed at that particular time (Remington and Schork 1970). Association of independent variables (sex and age) and

Fig. 1 Map of Razavi Khorasan Province showing Mashhad County where stray dogs were collected

prevalence of infection was evaluated using Chi Square test and Fischer exact test. All statistical analyses were performed by SPSS version 16 and *P* value less than 0.05 was considered as significant.

Result

The overall prevalence of infection with parasites was 86 % (95 % CI: 79.2–92.8 %), with 86 infected dogs of 100 animals tested by necropsy. The most frequently observed parasite was *Taenia hydatigena*, present in 43 % of examined animals, followed by *Dipylidium caninum* (39 %), *Echinococcus granulosus* (38 %), and *Toxocara canis* (29 %) (Table 1).

There were no significant differences in prevalence observed either between female (83.6 %) and male (89.7 %) or between young (89 %) and adult (72.2 %) animals. However, the prevalence of *E. granulosus*,

T. hydatigena and *D. caninum* showed an increasing trend with increasing host age, significantly (Table 2).

Discussion

Understanding the epidemiology of zoonotic parasitic infections is important for minimization of the risk to humans. The overall prevalence of intestinal helminths found in this study is 86 %, revealing a very high level of infection. Similar findings were also reported with intestinal helminths from Mashhad (91 %, Razmi et al. 2006) and Chenaran (66 %, Beiromvand et al. 2013) in Razavi Khorasan province and other studies conducted in different part of Iran, such as those of western part of Iran (89.15 %, Dalimi et al. 2006), central part of Iran (80 %, Eslami et al. 2010) and north part of Iran (90 %, Gholami et al. 2011). Prevalence of helminths in stray dogs of Mashhad is similar to prevalence rates reported in stray or domestic dogs in South Africa (76 %, Minner et al. 2002), South America (71 % in Galapagos, Gingrich et al. 2010; 86 % in Argentina, Fontanarrosa et al. 2006; 85 % in Mexico City, Eguia-Aguilar et al. 2005 or 35 % in Venezuela, Ramirez-Barrio et al. 2004), Spain (71 % in Cordoba, Martínez-Carrasco et al. 2007), Poland (68 %, Bajera et al. 2011), northeast Brazil (82.6 %, Klimpel et al. 2010) and Nigeria (52.6 % in Nigeria, Okoye et al. 2011) rather than to those typically seen in North Europe, where very low prevalence values are reported such as 6 % in Finland (Pullola et al. 2006) and 9.4 % in Germany (Becker et al. 2012). Generally, these results can be easily explained, as these animals have no health control measures and, because of their habits, they are exposed to natural infection more than owned dogs. Although the exact role of these populations in the transmission of parasites to man is not clearly determined (Eguia-Aguilar et al. 2005), they may be an

Table 1 Prevalence of gastrointestinal helminths in stray dogs at Mashhad city, Iran

Helminths	Species	Prevalence (95 % CI)
Nematodes	<i>Toxocara canis</i>	29 (20.2–37.8)
	<i>Toxascaris leonina</i>	7 (2–12)
	<i>Ancylostoma caninum</i>	2 (0–4)
Cestodes	<i>Taenia hydatigena</i>	43 (33.3–52.7)
	<i>Echinococcus granulosus</i>	38 (28.5–47.5)
	<i>Dipylidium caninum</i>	39 (29.5–48.5)
	<i>Mesocostoides lineatus</i>	16 (8.9–23.1)
	<i>Taenia multiceps</i>	11 (4.9–17.7)
	<i>Taenia ovis</i>	3 (0–6.3)

Table 2 Prevalence of gastrointestinal helminths in relation to age and sex in stray dogs at Mashhad city, Iran

Helminths	Prevalence, total (%)					Significance (<i>P</i> value)
	Age		Sex	Significance (<i>P</i> value)		
	≤1 year (n = 18)	>1 year (n = 82)				
	Male (n = 61)	Female (n = 39)				
<i>Toxocara canis</i>	8 (44.4)	21 (25.6)	>0.05	14 (22.9)	15 (38.4)	>0.05
<i>Toxoascaris leonina</i>	2 (11.1)	5 (6)	>0.05	4 (6.5)	3 (7.6)	>0.05
<i>Ancylostoma caninum</i>	0	2 (2.4)	>0.05	2 (3.2)	0	>0.05
<i>Taenia hydatigena</i>	0	43 (52.4)	<0.05	22 (36)	21 (53.8)	>0.05
<i>Echinococcus granulosus</i>	3 (16.6)	37 (45.1)	<0.05	21 (34.4)	17 (43.5)	>0.05
<i>Dipylidium caninum</i>	4 (22.2)	35 (42.6)	<0.05	27 (44.2)	12 (30.7)	>0.05
<i>Mesocestoides lineatus</i>	2 (11.1)	14 (77.7)	>0.05	11 (18)	5 (12.8)	>0.05
<i>Taenia multiceps</i>	1 (5.5)	10 (12.1)	>0.05	9 (14.7)	2 (5.1)	>0.05
<i>Taenia ovis</i>	0	3 (3.6)	>0.05	1 (1.6)	2 (5.1)	>0.05

important source of infection for humans and constitute a relevant public health problem.

The overall frequently of *E. granulosus* (38 %) obtained here is comparable to those obtained in previous studies (Motakef et al. 1976; Razmi et al. 2006). Similarly, in a widespread study conducted in different provinces of Iran, the prevalence of *E. granulosus* in stray dogs was detected as 6.8–50.5 % (Hoghoghi 1971; Sharifi and Tasbiti 1994; Eslami and Hosseini 1998; Mehrabani et al. 1999). These data suggest that the rate of *Echinococcus* infection in stray dogs in this area has been increased and national programme which included the elimination of stray dogs has not been efficient for decreasing the rate of *Echinococcus* infection in recent years.

Generally, one of the main reasons for high prevalence of *E. granulosus* in stray dogs in this region is thought to be due to the lack of proper information regarding the life cycle of the parasite by abattoir workers, butchers and dog owners and the lack of enforcement of regulations governing infected offal disposal in the rural areas. In Iran, most of the human cases of this infection are reported in sheep rearing regions mainly in the rural and nomadic migratory tribe populations. It should be noted that the Razavi Khorasan province is also known as one of the most important sheep raising areas in the country. Furthermore, it was encountered that there was a considerable within geographical difference which the highest prevalence of human hydatidosis has been reported from Razavi Khorasan province (Rokni 2009). The main reason for this infection might be certain human activities, such as feeding the viscera of butchered sheep to dogs or leaving the viscera for stray dogs can facilitate transmission of the sheep strain and consequently increase the risk of transmission to humans.

Based on our data, the age of the dogs was found to be an important risk factor associated with *E. granulosus* infection which older animals are more prone to acquire the infection. Similar findings were reported by Tackmann et al. (1998) who found the prevalence was significantly higher in juveniles under high-endemic conditions and higher in adults under low-endemic conditions. They estimated those findings were related to the level of acquired intestinal immunity to the cestodes in various endemic conditions. The studies from Razavi Khorasan (Borji et al. 2011; Borji et al. 2012a) and different parts of Iran (Rokni 2009; Borji and Parandeh 2010; Borji et al. 2012b) confirm the fact that Iran is an endemic area for *E. granulosus*. However, Eslami and Hosseini (1998), Maleky and Moradkhan (2000) and Razmi et al. (2006) noted that age-dependent difference was not significant. Roberts et al. (1986) modeled the effect of immunity in dogs as a decrease in the asymptotic prevalence of infection when compared to dogs that did not develop immunity. By repeated numbers of challenge infections, susceptibility of

dogs to *E. granulosus* was reduced to ~50 % by the sixth infection and theoretically at 99 % by the 12th infection (Gemmell 1997).

The ascarid *T. canis* is a very common intestinal helminth in domestic and wild canids and is also the agent of human toxocariasis. The overall frequently of *T. canis* (29 %) obtained here is comparable to those obtained in previous studies from Iran (Dalimi et al. 2006; Razmi et al. 2006; Eslami et al. 2010). Additionally, a number of recently conducted surveys of canine parasitism in the other region reported *T. canis* as the most or second most prevalent intestinal nematode parasite of dogs (Fontanarrosa et al. 2006; Papazahariadou et al. 2007; Bridger and Whitney 2009; Gates and Nolan 2009; Shalaby et al. 2010; Xhaxhiu et al. 2011; Becker et al. 2012). These data suggest that there was no significant downward long-term in the prevalence of this parasite as reported in other countries. Furthermore, no significant differences were observed between the proportions of juvenile and adult dogs infected with *T. canis* which consistent with result of Omar and Lewis (1993) from Egypt and Bajera et al. (2011) from Poland. In comparison, other findings from other geographic regions revealed that *T. canis* was higher in puppies than in older dogs (Razmi et al. 2006; Papazahariadou et al. 2007; Gholami et al. 2011; Okoye et al. 2011; Xhaxhiu et al. 2011). As regards the effect of gender, in accordance with Fontanarrosa et al. (2006); Martínez-Carrasco et al. (2007) and Martínez-Moreno et al. (2007), there was no significant difference in the overall prevalence of *T. canis* infection between males and females. Reviewing the literature, Papazahariadou et al. (2007) described a tendency of *T. canis* infections to occur more often in adult male than female dogs. This was not supported by the present study. Despite no difference of prevalence of infection and equivalent *T. canis* counts, heavily infected >1-year old dogs were more likely to be female than male. Although dogs of any age can become patent infected with *T. canis* (Fahrion et al. 2008), an explanation for this observation might be that adult female dogs are more likely to acquire *T. canis* by ingesting infective eggs or intestinal *T. canis* stages expelled by their puppies in connection with immunosuppressive phenomena associated with pregnancy and lactation. This hypothesis has been discussed by Omar and Lewis (1993) and Bridger and Whitney (2009) who found *T. canis* in significantly more female dogs than male.

Contrary to *T. canis*, *T. leonina* infections are less pathogenic for dogs, and there is no evidence of zoonotic potential for this parasite. Prevalence rates of *T. leonina* reported in earlier studies were lower than those of *T. canis* (Dalimi et al. 2006; Razmi et al. 2006; Papazahariadou et al. 2007; Gates and Nolan 2009; Gholami et al. 2011; Becker et al. 2012).

Another very common parasite found in the evaluated dogs was *T. hydatigena* (43 %), which shows that this helminth is the main intestinal helminth found in these animals, mostly in older animals, as indicated by previous studies in Iran and all other countries (Dalimi et al. 2006; Razmi et al. 2006; Eslami et al. 2010). In this study, the prevalence of *T. hydatigena* was significantly higher in adult animals than in young which in agreement with Razmi et al. (2006) and Xhaxhiu et al. (2011) that they reported more infection rate in animals older than one year old. The reasons explaining highest prevalence of *T. hydatigena* in the old dogs are unknown. Thus, this result implied that the dog did not acquire immunity to reinfection or superinfection with *T. hydatigena*.

Following *T. hydatigena*, *D. caninum* was the second most frequently recorded cestode in this study. Its prevalence in the present study (38 %) was in the range of other recent studies of intestinal parasitism in canines from this region (Razmi et al. 2006; Eslami et al. 2010; Gholami et al. 2011). *Dipylidium caninum* is especially common in dogs which are frequently infested by fleas as reported for dog in other country (Fontanarroza et al. 2006; Xhaxhiu et al. 2011). In principal, the prevalence of *D. caninum* was also significantly more in adult animals. Consistent with the findings of surveys from other geographic regions (Saeki et al. 1997; Xhaxhiu et al. 2011), *D. caninum* was detected much more frequently in the older dogs than in puppies. This difference could be due to more opportunities of infestation with lice and flea in adult stray dogs compared to young dogs.

One species of hookworm, *A. caninum*, was recorded in the dogs from this area with low infection rate (2 %). Generally, the prevalence of *A. caninum* found in the dogs from this area fitted well within the range reported in other studies from the region (Razmi et al. 2006). As regards prevalence, this pattern has been found in the majority of recent studies from other area in Iran too (Dalimi et al. 2006). Comparable with the findings of other studies (Fontanarroza et al. 2006; Martínez-Carrasco et al. 2007; Martínez-Moreno et al. 2007; Gates and Nolan 2009; Becker et al. 2012), hookworms were found more frequently in older dogs compared to <1-year old puppies. This increase in frequency was the case for both species of hookworm, although in some studies, *Ancylostoma* infections were claimed to occur quite often in very young dogs because neonatal pups might become infected via the transmammary route (Coggins 1998; Little et al. 2009).

Mesosestoides lineatus, *T. multiceps* and *T. ovis* infection was recorded in 16, 11 and 3 % of the stray dogs from Mashhad area with generally low individual counts, respectively. The rates of canine infection with these helminths observed in recent surveys from other area of Iran ranged from 2 to 26 % (Dalimi et al. 2006; Razmi et al. 2006; Eslami et al. 2010).

It is apparent from this study that the dogs of the suburban areas of Mashhad County carry several intestinal parasites at high prevalence, some of which can be important sources of zoonotic diseases in humans and pose a threat to community health. It is, therefore, recommended that veterinarians should play a significant role in raising awareness about this aspect of the human–dog relationship and should educate the local population about the potential risks. Finally, it is recommended to determine the most appropriate preventive methods for the control of gastrointestinal helminth of stray dogs including providing a higher level of care for the dogs and effective anthelmintic treatment.

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