J Parasit Dis (Oct-Dec 2017) 41(4):1006–1013
DOI 10.1007/s12639-017-0926-2

ORIGINAL ARTICLE

Epidemiological investigation of gastrointestinal parasites in dog populations in Basra province, Southern Iraq

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Received: 14 February 2017 / Accepted: 12 May 2017 / Published online: 22 May 2017

Abstract The understanding of the epidemiology of canine parasitic infections is necessary for an efficient control program to minimize the risk of zoonotic transmission. The objectives of this study were (1) to determine the prevalence of canine gastrointestinal helminths and protozoa in Basra province, Southern Iraq, and (2) to identify the association of epidemiological characteristics (age, breed, gender, and feed type) of dogs with the parasitic infections. A total of 93 fecal samples, collected in the period from December 2014 to June 2015, were examined macroscopically and microscopically for the presence of worm eggs and protozoal oocysts, using centrifugal flotation method. The overall prevalence of infected dogs was 77.4% (72/93). About 54.8% (51/93) dogs were infected with more than one genus of parasites. The prevalence of multiple infections with two, three, and four parasites was 30.1% (28/93), 22.6% (21/93), and 2.2% (2/93), respectively. The most frequently detected parasites were *Toxocara canis* (62.4%, 58/93), *Physaloptera* spp. (28%, 26/93), *Alaria* spp. (26.9%, 25/93), *Trichuris vulpis* (9.7%, 9/93), and *Ancylostoma caninum* (7.5%, 7/93). *Isospora canis* (6.5%, 6/93) and *Giardia* spp. (4.3%, 4/93) were the only protozoan parasites identified in this study. *Toxocara canis* infection was significantly associated with sex and age of the dogs ($P < 0.05$). Feeding type was significantly associated with the occurrence of *T. canis* ($P < 0.0001$), *A. caninum* ($P < 0.03$) and *Alaria* spp. ($P < 0.02$). The high prevalence of intestinal helminths in dog's population suggesting the need for more efficient control measures. The high prevalence of *T. canis*, *T. vulpis, A. caninum and Giardia* spp. suggested that dogs could play an active role in the transmission of zoonotic parasites in this area of Iraq. Educating the dog owners and increasing their health awareness should be considered in the control program. The results of the present study provide relevant "baseline" data for assessing the effectiveness of future control strategies against canine parasitic infections.

Keywords Epidemiology · Dogs · Helminths · Protozoa · Prevalence · Gastrointestinal parasites

Introduction

Dogs are one of the most common companions of humans among the animals. They are raised and kept for various reasons such as hunting, companionship, guarding, and more recently aiding handicapped individuals (Wang et al. 2006; Bridger and Whitney 2009). Dogs have a close relationship with human as a pet, mostly involving emotional development, socialization, and physiological well-being of humans (McGlade et al. 2003). Furthermore, dogs receive considerable attention worldwide because they serve as the reservoirs, carriers, and transmitters of several parasites, which are zoonotic and present a significant public health concern (Traub et al. 2005; Inpankaew et al.

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2007; Gracenea et al. 2009; Schär et al. 2014; Emamapour et al. 2015). Many previous studies have documented that dogs are associated with several zoonotic diseases; of them, gastrointestinal parasites are of a significant importance to public and veterinary health (Sager et al. 2006; Martínez-Moreno et al. 2007).

Gastrointestinal parasites, both protozoa and helminths, are among the most common pathogenic agents in dogs worldwide and contribute a significant proportion of diagnosed intestinal pathology in dogs (Bridger and Whitney 2009; Ferreira et al. 2011; Savilla et al. 2011). The most commonly identified canine helminths parasites are *Ancylostoma* spp., *Toxocara* spp., *Strongyloides* spp., *Echinococcus* spp., and *Trichuris* spp. (Thompson and Smith 2011; Schär et al. 2014; Ferreira et al. 2016). On the other hand, the most commonly reported canine protozoon parasites are *Giardia* spp., *Isospora* spp., and *Cryptosporidium* spp. (Traub et al. 2004; Ferreira et al. 2011; Savilla et al. 2011).

A greater insight into the epidemiology of parasitic infections in dog's population is important for improving the control program and, subsequently, minimizing the risk of zoonotic transmission to humans. Therefore, gathering more information on the prevalence of the parasites affecting dogs is crucial for developing veterinary and public health strategies for their treatment and control (Palmer et al. 2008; Schär et al. 2014).

In the recent decades, many areas in Iraq, including Basra province, have suffered from the turmoil and the increasing security disturbance. This was followed by an increase in the demands of purchasing and importing different dogs breeds for security and guarding purposes. It is essential to keep these dog populations healthy and free from parasitic infections. However, to the best of our knowledge, there is no study in the literature about the prevalence and type of different canine parasites in Iraq. Furthermore, previous studies have reported infection with some parasites in different human populations, which have a zoonotic importance and public health hazards where dogs act as a main reservoir or host (Mahdi and Ali 2002; Duda et al. 2015). These studies were accrued out at different provinces across Iraq including Dohuk (Al-Saeed and Issa 2006), Arbil (Saeed et al. 2000), Sulaimani (Mohammed 2013) and Mosul (Al-Saeed et al. 2009). In Basra, the province of current study, few studies identified different parasites of zoonotic importance from the stool of individuals examined at Basra General Hospital such as *Cryptosporidium* spp., *Blastocystis hominis, Echinococcus granulosus, Giardia lamblia,* and *Trichiurus trichiura* (Mahdi and Ali 2002; Yacoub et al. 2006; Abu Tabeekh and Thuwaini 2015). Therefore, it is important to gain the knowledge on the type and prevalence of canine gastrointestinal parasites and their epidemiological characteristics in order to establish a database. Subsequently, effective control measures can be developed and implemented for the control of infections in animals and, ultimately, prevent or at least minimize the zoonotic risk for humans beings. This study presents the first report about epidemiology of canine gastrointestinal parasites in Iraq with the following objectives (1) to determine the prevalence of gastrointestinal parasites in the dog's population in Basra province, and (2) to identify the association of epidemiological characteristics (age, breed, gender, and feed type) of dogs with the parasitic infections.

Materials and methods

Study population and sample collection

From December 2014 to June 2015, fecal samples of 93 dogs from different veterinary clinics were collected by Siha private veterinary laboratory, Basra province, Iraq for parasitological diagnosis. The fecal samples were collected at the veterinary clinics directly from the rectum. The samples were transported to the laboratory on ice packs and refrigerated for no more than 24 h prior the examination. The data regarding the dog's breed, age, gender and type of feed were obtained from the owners and supplied with the samples. The information about the frequency and types of anthelmintic treatment of the sampled dogs was very limited.

Diagnostic techniques

Fecal samples were first inspected grossly for the presence of adult helminths and cestodes proglottids using conventional macroscopic techniques and then were examined for the eggs, oocysts and cysts using a centrifugal flotation method using saturated solution of sodium chloride (Zajac and Conboy 2006). Briefly, approximately 5 g of feces were placed into a paper cup. Sodium chloride solution (40 mL) was added to each sample and mixed well. The mixture was sieved through a metallic tea strainer (mesh size 0.9 mm) into a second clean cup, and then poured into test tube until it was 0.5 cm from the top. Sodium chloride solution was added to fill the tube until a convex meniscus formed. A cover slip was then placed over the top of the tube. The samples were then centrifuged for 10 min. After centrifugation, the cover slip was carefully removed vertically, placed on a glass slide and were examined under light microscope.

All protozoa cysts or oocysts and helminth forms were identified on the basis of morphological characteristics according to the keys and the guideline given by Bowman

et al. (2003) using light microscopy. The results were expressed as the presence or absence of parasites. A fecal sample was considered to be positive if at least one parasitic form was observed. The identification of *Dipylidium caninum* was based on the visual observation of proglottids in feces or on the detection of ovigerous capsules by the means of centrifugal sedimentation method.

Data analysis

The dogs under this study belonged to four different kinds of breeds: Siberian Husky, Pit bull, German Shepherd, and Shetland Sheepdog. The dogs were classified according to their age (<2 years or ≥2 years), sex (male and female); feed type (commercial, ready-made pullets or free mixed feeding) (Table 1).

The overall prevalence was defined as the percentage of fecal samples positive for any parasite species, and the specific prevalence as the percentage of fecal samples positive for a given parasite species. The frequency of positive animals and the respective binomial 95% confidence intervals were calculated for each parasite. The associations between the frequencies of positivity for each parasite and the independent variables of age, breed, sex and feed were investigated using Chi square test. All statistical analyses were performed using R v3.0.3 (R Core Team. http://www.R-project.org), and the significance was defined at P value < 0.05.

Results

The prevalence of protozoa cysts or oocysts and different helminths are presented in Tables 2 and 3. The overall prevalence of infection with intestinal parasites was 77.4% (72/93). Twelve genera of intestinal parasites were detected and helminth infections were more prevalent than protozoan parasites (Table 2).

The most frequently observed parasites was *T. canis* 62.4% (58/93), followed by *Physaloptera* spp. 28% (26/93), *Alaria* spp. 26.9% (25/93), *T. vulpis* 9.7% (9/93), and *A. caninum* 7.5% (7/93). *I. canis* and *Giardia* spp. were the only identified intestinal protozoan parasites with a prevalence of 6.5% (6/93) and 4.3% (4/93), respectively. The infections with multiple parasite species (54.8%, 51/93) were more frequent than those with a single parasite species (22.6%, 21/93) (Tables 3 and 4). It was observed multiple infections with two (30.1%, 28/93), three (22.6%; 21/93) and four parasites (2.2%; 2/93). Dogs with more than two-year-old (57%, 53/93) had a higher overall parasitic prevalence than those of less than two years of age (20.4%, 19/93). The male dogs (59.1%, 55/93) had a higher overall prevalence of infections than female ones (18.3%, 17/93). The dogs with free feeding system (62.4%, 58/93) had a higher overall prevalence of infections than those with bullet feeding (15.1%, 14/93). The Siberian Husky breed dogs (33.3%, 31/93) had a higher overall prevalence of infections than the other dog breeds (Table 4). The associations between the presence of a parasite and sex, breed, feed type, and age ($P < 0.05$) are shown in Table 5.

Toxocara canis infection was significantly associated with sex ($P < 0.03$) and age ($P < 0.001$) of the investigated dogs, where male dogs and those group ≥ 2 years old were more susceptible to infection. Feeding type was significantly associated with the occurrence of *T. canis* ($P < 0.0001$), *A. caninum* ($P < 0.03$) and *Alaria* spp. ($P < 0.02$), where dogs fed on free mixed feed are more susceptible to infection. No significant difference was found between the type of gastrointestinal parasites and dog's breed.

Discussion

To the best of our knowledge, this is the first report concerning the prevalence of canine gastrointestinal parasites in the southern part of Iraq, Basra province. The overall prevalence of canine intestinal parasites was found to be 77.4% revealing a high level of infection that requires an

Table 1 Description of 93 domestic dogs of different breeds from Basra, Southern Iraq examined for gastrointestinal parasites infection during the period from December 2014 to June 2015

Dog breed	Feed type		Sex		Age		Total
	Free	Pullet	Female	Male	<2 years	≥2 years	
Pit bull	6	6	5	7	7	5	12
German shepherd	13	16	6	23	5	24	29
Siberian Husky	31	8	15	24	16	23	39
Sheepdog	9	4	6	7	7	6	13
Total	59	34	32	61	35	58	93

Table 2 Number and prevalence (%) of gastrointestinal parasites in 93 domestic dogs of different breeds from Basra, Southern Iraq examined during the period from December 2014 to June 2015

Parasites species	No. of infected dogs	Prevalence (%)	CI 95 (%)
Alaria spp.	25	26.9	18.9–36.7
Ancylostoma caninum	7	7.5	3.7–14.7
Dipylidium caninum	6	6.5	3.0–13.4
Paragonimus westermani	4	4.3	1.7–10.5
Physaloptera spp	26	28	19.9–37.8
Toxocara canis	58	62.4	52.2–71.5
Trichuris vulpis	9	9.7	5.2–17.4
Capillaria plica	1	1.1	0.2–5.8
Toxascaris leonina	1	1.1	0.2–5.8
Strongyloides spp.	1	1.1	0.2–5.8
Giardia spp.	4	4.3	1.7–10.5
Isospora canis	6	6.5	3.0–13.4
*Total**	77	100	

* Total is greater than 72 because some of the examined dogs were infected by multiple parasites (Multiple parasitism)

effective anti-parasite control program. This high prevalence may reflect the favorable conditions for environmental contamination and the transmission of gastrointestinal parasites through the fecal-oral route (Alvarado-Esquivel et al. 2015). Several earlier studies have reported a wide variation in the intestinal parasitic infections among the dog populations from different countries and geographical regions. Our estimates of the prevalence of dog intestinal parasites were similar to the earlier reports such as 85% in Mexico (Eguia-Aguilar et al. 2005), 71% in Spain (Martínez-Moreno et al. 2007), 68% in Poland (Bajer et al. 2011), 66% in Iran (Beiromvand et al. 2013), and 57.9% in France (Bridger and Whitney 2009). In some countries, low prevalence, compared to our study, has been reported, e.g., 35.5% in Venezuela (Ramirez-Barrioes et al. 2004), 37.9% in Argentina (Soriano et al. 2010), and 33.6% in West Virginia, USA (Savilla et al. 2011). This wide variation between the different studies may be explained by some factors such as geographical location, different sampling protocols, socio-economic level, demographic factors, anthelmintic usage and deworming drugs and frequency, and diagnostic techniques employed (Pullola et al. 2006; Katagiri and Oliveira-Sequeira 2008; Soriano et al. 2010; Beiromvand et al. 2013; Schär et al. 2014).

In our study, 10 helminths and two protozoan parasites were recovered. The most commonly encountered parasites were *T. canis* (58/93, 62.4%), *Physaloptera* spp. (26/93, 28%), *Alaria* spp. (25/93, 26.9%), *T. vulpis* (9/93, 9.7%), and *A. caninum* (7/93, 7.5%). This finding is in agreement to previous studies from Pennsylvania state (USA), that reported these parasites as the most commonly found helminths in dogs (Kirkpatrick 1988; Nolan and Smith 1995). Among the parasites found in our study, three parasites, viz., *T. canis, A. caninum* and *Giardia* spp., are of particular importance as they are well-recognized zoonotic agents that can pose a significant public health threat due to the close contact between humans and their pets (Kirkpatrick 1988). A similar observation was also made earlier (Labruna et al. 2006; Katagiri and Oliveira-Sequeira 2008). *T. canis*, the most commonly helminth in this study, was also the most prevalent in studies from Brazil, Turkey and Iraq (Oliveira-Sequeria et al. 2002; Senlik et al. 2006;

Table 3 Number of single and multiple infections for each parasite in 93 domestic dogs from Basra, Southern Iraq examined during period from December 2014 to June 2015

Parasites species	Number of parasite species in infected dogs				Total
	1	2	3	4	
Alaria spp.	2	10	11	2	25
Ancylostoma caninum	0	2	5	0	7
Dipylidium caninum	3	1	2	0	6
Paragonimus westermani	0	0	3	1	4
Physaloptera spp.	1	10	13	2	26
Toxocara canis	10	26	20	2	58
Trichuris vulpis	1	1	6	1	9
Capillaria plica	0	1	0	0	1
Toxascaris leonina	0	1	0	0	1
Strongyloides spp.	0	1	0	0	1
Giardia spp.	1	1	2	0	4
Isospora canis	3	2	1	0	6
Total[1]	21	56	63	8	150

[1] Total is greater than 72 because some of the examined dogs were infected by multiple parasites (Multiple parasitism)

Table 4 Frequency (%) of single and multiple parasitic infections in domestic dogs by breed, sex, feed type, and age from Basra, Southern Iraq examined during period from December 2014 to June 2015

Frequency of infections	Breed (%)				Feed (%)		Sex (%)		Age (%)		Total
	Pit bull	German shepherd	Siberian Husky	Sheepdog	Free	Pullet	Female	Male	<2 years	≥2 years	
Single infection	0	8 (38)	12 (57.1)	1 (4.8)	18 (85.7)	3 (14.3)	3 (14.3)	18 (85.7)	6 (28.6)	15 (71.4)	21
Double infections	4 (14.3)	12 (42.9)	11 (39.3)	1 (3.6)	22 (78.6)	6 (21.4)	6 (21.4)	22 (78.6)	6 (21.4)	22 (78.6)	28
Triple infections	2 (9.5)	7 (33.3)	7 (33.3)	5 (23.8)	16 (76.2)	5 (23.8)	8 (38)	13 (62)	7 (33.3)	14 (66.7)	21
Quadruple infections	0	0	1 (50)	1 (50)	2 (100)	0	0	2 (100)	0	2 (100)	2
Total*	6 (6.5)	27 (29)	31 (33.3)	8 (8.6)	58 (62.4)	14 (15.1)	17 (18.3)	55 (59.1)	19 (20.4)	53 (57)	72 (77.4)

*The proportions were calculated based on the total number of examined dogs (n = 93)

Table 5 Association of sex, age, breed and feed type to prevalence (%) of gastrointestinal parasites in fecal samples from 93 domestic dogs from Basra, Southern Iraq examined during period from December 2014 to June 2015

Parasites	Sex (%)		Age (%)		Breed (%)				Feed (%)		Total (n = 93)
	Female (n = 32)	Male (n = 61)	<2 years (n = 35)	≥2 years (n = 58)	Pit bull (n = 12)	German shepherd (n = 29)	Siberian Husky (n = 39)	Sheepdog (n = 13)	Free (n = 59)	Pullet (n = 34)	
Toxocara canis	15 (46.9)*	43 (70.5)*	14 (40)*	44 (75.9)*	6 (50)	22 (75.9)	22 (56.4)	8 (61.5)	47 (79.7)*	11 (32.4)*	58 (62.4)
Dipylidium caninum	3 (9.4)	3 (4.9)	2 (5.7)	4 (6.9)	0	2 (6.9)	2 (5.1)	2 (15.4)	5 (8.5)	1 (2.9)	6 (6.5)
Ancylostoma caninum	3 (9.4)	4 (6.6)	2 (5.7)	5 (8.6)	0	0	5 (12.8)	2 (15.4)	7 (11.9)*	0 *	7 (7.5)
Alaria spp.	5 (15.6)	20 (32.8)	8 (22.9)	17 (29.3)	2 (16.7)	9 (31)	10 (25.6)	4 (30.8)	21 (35.6)*	4 (11.8)*	25 (26.9)
Giardia spp.	0	4 (7.3)	2 (5.7)	2 (3.5)	0	2 (6.9)	2 (5.1)	0	2 (3.4)	2 (5.9)	4 (4.3)
Trichuris vulpis	2 (6.3)	7 (11.5)	1 (2.9)	8 (13.8)	1 (8.3)	3 (10.3)	3 (7.7)	2 (15.4)	6 (10.2)	3 (8.8)	9 (9.7)
Physaloptera spp.	5 (15.6)	21 (34.4)	7 (20)	19 (32.8)	3 (25)	10 (34.5)	10 (25.6)	3 (23.1)	20 (33.9)	6 (17.7)	26 (28)
Strongyloides spp.	0	1 (1.6)	0	1 (1.7)	0	1 (3.5)	0	0	0	1 (2.9)	1 (1.1)
Paragonimus westermani	2 (6.3)	2 (3.3)	1 (2.9)	3 (5.2)	1 (8.3)	0	2 (5.1)	1 (7.7)	4 (6.8)	0	4 (4.3)
Capillaria plica	1 (3.1)	0	1 (2.9)	0	0	0	1 (2.6)	0	1 (1.7)	0	1 (1.1)
Isospora canis	2 (6.3)	4 (6.6)	1 (2.9)	5 (8.6)	0	4 (13.8)	2 (5.1)	0	4 (6.8)	2 (5.9)	6 (6.5)
Toxascaris leonina	1 (3.1)	0	0	1 (1.7)	1 (8.3)	0	0	0	1 (1.7)	0	1 (1.1)

*($P < 0.05$) between the categories within the same variable

Khalaf et al. 2015). *A. caninum* is considered as one of the most pathogenic and frequently isolated intestinal parasites of dogs. Both the larvae and adults of *A. caninum* are involved in human infections (Katagiri and Oliveira-Sequeira 2008). The prevalence of *Giardia* spp. was 5.6%, which is similar to studies from Canada (Gaunt and Carr 2011) and USA (Little et al. 2009), which found a prevalence of 4%. Higher prevalence was found by Bahrami et al. (2011), 18.8%, in stray dogs in Iran, by Claerebout et al. (2009), in Belgium, 9.3%, also in Portugal, 7.4% where Neves et al. (2014) reported a prevalence of 7.4% in apparently healthy dogs and 15.5% in dogs with gastrointestinal disorders. The prevalence of the whipworm (*T. vulpis*) in dogs was considerably high. Although the parasite is rarely found in humans, many studies have documented that it can cause an uncommon and severe zoonosis (Márquez-navarro et al. 2012; Kimura et al. 2013). Our findings are in accordance with those studies, which reported zoonotic parasites from inhabitants of Basra province (Yacoub et al. 2006). Mahdi and Ali (2002) found that 26 of 175 apparently healthy individuals (14.8%) admitted to three hospitals in Basra during November 1997-May 1998, had intestinal parasitic infections with *B. hominis* (36%) and *G. lamblia* (28%) as most common intestinal parasites. These reports confirm the active role of dogs as a host and reservoir for common zoonotic parasites in Basra province. These previous reports with our findings indicate the crucial necessity for efficient control strategies to combat the zoonotic parasites in dogs and humans.

Physaloptera spp. were the second more prevalent gastrointestinal helminth in our study, with a prevalence of 28%. These parasites have not been commonly described in recent investigations but the prevalence was quite high in the USA a few decades ago (Kazacos 1978; Burrows 1983). In recent times, there are few studies documenting *Physaloptera* spp., which reported a low prevalence of 2.4% in dogs in Ghana (Amissah-Reynolds et al. 2016), and 1.9% in Mexico (Cantó et al. 2011). In the present study, the prevalence of *Alaria* spp., intestinal flukes of dogs, was remarkably high (26.9%). There is limited

information about the prevalence of this trematode parasite in the dog population at the global level. This parasite is rarely documented in dogs in North America (Pomroy 1999). In Canada, Gaunt and Carr (2011) reported a low prevalence for *Alaria* spp., which is about 4%. In Denmark, Al-Sabi et al. (2013) found that the prevalence of *A. alata* in raccoon dogs (69.7%) was higher than in foxes (34.4%). The latter study may indicate that *Alaria* spp. infections may be associated with the wildlife contact. Furthermore, Pomroy (1999) stated that dogs and wild mammals are typically infected by *Alaria* spp. through ingestion of second intermediary hosts such as a frog or tadpole.

Notably, the high prevalence of *Physaloptera* and *Alaria* spp. in this study may reveal the re-emergence of such parasites in the dog's population. Further, it may also indicate that the presence of such parasites in dogs is associated mainly with wild animals contact. These parasites seemed to be eradicated from the developed countries, mainly Europe and North America, as in recent years there have been reports about the gastrointestinal parasitic infections in dogs by any of these parasites. A possible reason could be that the developed countries are equipped with well-established and effective control programs, veterinary care, and good deworming strategies. Other reasons might be the lack of contact between the wild carnivores (e.g., red fox) and dog populations, and an effective working of anthelmintic drugs against *Physaloptera* and *Alaria* spp. disrupting their life cycles and preventing their spread in dog populations.

In the present investigation, the poly-infections were more common than the single-infections; this observation is similar to the findings of previous studies (Dalimi et al. 2006; Eslami et al. 2010; Alvarado-Esquivel et al. 2015). However, other previous studies showed that single-infections were more common then and poly-infections (Kirkpatrick 1988; Ramirez-Barrioes et al. 2004; Riggio et al. 2013). This observed variation between our study and previous ones could be explained by the differences in the dog breed, age, sex, feeding system, localities, climate condition, and environmental factors. The multiple parasitisms in our study may be due to the limited veterinary care programs and the lack of awareness of zoonotic diseases among dog owners, which increases the risk of disease transmission among dog populations.

In this study, the prevalence of *T. canis* was significantly higher in male than in female dogs. This finding agrees with findings of previous studies (Kirkpatrick 1988; Oliveira-Sequeria et al. 2002; Senlik et al. 2006) who showed that *T. canis* infections tend to be more common in male dogs. However, Bridger and Whitney (2009) found that *T. canis*, which was more common in female dogs than male dogs. Hormonal factors and sex associated behavior as roaming may explain this noted variations (Kirkpatrick 1988). *T. canis* was significantly higher in dogs with more than two years old. This finding disagrees with previous reports (Fok et al. 2001; Ramirez-Barrioes et al. 2004; Senlik et al. 2006; Riggio et al. 2013) who found that the highest infection rate of *T. canis* occurred in the youngest dogs possibly as a result of intra-uterine or transmammary infection. Sample sizes in our study were much lower than those reported elsewhere which could be a plausable reason.

Feeding type has a significant effect on the infection with *T. canis*, *A. caninum* and *Alaria* spp. where dogs fed on free mixed feed were more susceptible to infection. The dogs that are fed on free mixed feed have a higher risk of infection than the dogs that are fed on pullet. The possible explanation could be the environmental contamination of the ration during handling and management or of the feed containers. Zelalem and Mekonnen (2012) found that uncooked feed might carry many parasites, while cooking of feed can kill or inactivate the infective eggs or cysts of gastrointestinal helminths, which could be transferred to dogs via feeding.

No significant association with the breed of the dogs and parasitic infections. This comes in agreement with previous studies (Fontanarrosa et al. 2006; Claerebout et al. 2009) but disagrees with other studies (Oliveira-Sequeria et al. 2002; Bridger and Whitney 2009) who found dog breed is significant predisposing factor for canine parasitic infections. Genetic difference among the different breeds could be an important factor involved in this variation. Oliveira-Sequeria et al. (2002) stated that pure-breed dogs tend to be from responsible owners and generally, it receive more and frequent anthelminthic treatments. Furthermore, increased the health awareness of dog's owners and better accessibility to adequate veterinary care could have an important impact.

The results of the present study provide relevant "baseline" data for assessing the effectiveness of future control strategies against parasitic infestations in dogs and substantially to reduce the spread of the parasites of potential public health hazard in Basra Province, Iraq.

Conclusion

In Basra, the prevalence of intestinal helminths in pet dogs is high suggesting the need for efficient control measures through regular diagnostic testing, the deworming pattern of dogs, preventive measures, and effective therapeutic protocols against them. The prevalence of zoonotic parasites including *T. canis*, *T. vulpis, A. caninum* and *Giardia* was found to be high, suggesting that the dog owners should be made aware of the control programs by the veterinarian and health service centers in the province to reduce the risk of human infections. The high prevalence of *Physaloptera* and *Alaria* spp. observed in this study and failing to find a similar pattern in other countries reveal the

re-emergence of such parasites in the dog population; therefore, improving the current veterinary care programs requires special attention to prevent their spread among dogs. Further studies are necessary to identify the potentially zoonotic gastrointestinal parasites in dogs and humans within the different communities in Iraq.

Acknowledgements We thank the veterinarians and staff members of veterinary clinics for their assistance in obtaining and processing fecal samples. We would also like to thank the anonymous dog owners who provided access to the data about their dogs.

Compliance with ethical standards

Conflict of interest The authors declare no conflict of interest. No competing financial interests exist.

Ethical approval All applicable international, national, and/or institutional guidelines for the care and use of animals were followed. All procedures performed in the study involving animals were in accordance with the ethical standards of the institution or practice at which the study was conducted.

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