aJava

Asian Journal of Animal and Veterinary Advances

Academic
Journals Inc.

www.academicjournals.com

OPEN ACCESS Asian Journal of Animal and Veterinary Advances

ISSN 1683-9919
DOI: 10.3923/ajava.2016.341.349

Research Article
Role of Pet Dogs in Transmitting Zoonotic Intestinal Parasites in Egypt

[1]M.A. Ibrahim, [1]K.A. Gihan, [2]S.M. Aboelhadid and [1]M.M. Abdel-Rahim

[1]Department of Hygiene, Management and Zoonoses,
[2]Department of Veterinary Parasitology, Faculty of Veterinary Medicine, Beni-Suef University, Beni-Suef, Egypt

Abstract

Objective: The objective of this study was to determine the prevalence of zoonotic intestinal parasites in pet dogs and their owners in Cairo and Giza Governorates, Egypt. **Methodology:** A total of 395 fecal samples collected from pet dogs beside 145 stool samples from humans were subjected to macroscopic and microscopic examination using different flotation and sedimentation techniques. **Results:** The overall prevalence of enteric parasites in the examined dogs was 25.6%. Higher prevalence was shown in police dogs (43.3%) followed by pet shop dogs (30.8%) and finally in household dogs (13.8%). *Cryptosporidium* was the most frequent parasite detected in the examined dogs (10.1%) and humans (10.3%), whereas *Giardia* was the lowest one (0.5 and 2.8% respectively). In addition, *Entamoeba histolytica/Entamoeba dispar* were found at a rate of 5.6% (dogs) and 7.6% (humans). *Trichuris vulpis*, *Toxascaris leonina* and *Toxocara canis* were identified only from the examined dogs at a rate of 3.3, 5.8 and 0.3% respectively. Young age (<6 months), female sex, local breed, undercooked feeding, outdoor housing and irregular de-worming were significantly associated with increased prevalence of the identified parasites in dogs. Regarding humans, the highest prevalence of enteric parasites was found in the age group between 5-10 years old (60%). Gender did not affect the risk of an infection in the study population. **Conclusion:** In conclusion, parasitological results in this study clearly highlight the significant role of pet dogs as a host for several species of enteric parasites; therefore preventive measures should be taken to avoid the environmental contamination and infection of both man and animals.

Key words: Pet, dogs, parasites, feces, humans

Received: December 14, 2015 Accepted: March 26, 2016 Published: May 15, 2016

Editor: Dr. Kuldeep Dhama, Principal Scientist, Division of Pathology, Indian Veterinary Research Institute (IVRI), Izatnagar, Uttar Pradesh, India

Citation: M.A. Ibrahim, K.A. Gihan, S.M. Aboelhadid and M.M. Abdel-Rahim, 2016. Role of pet dogs in transmitting zoonotic intestinal parasites in Egypt. Asian J. Anim. Vet. Adv., 11: 341-349.

Corresponding Author: M.A. Ibrahim, Department of Hygiene, Management and Zoonoses, Faculty of Veterinary Medicine, Beni-Suef University, 62511 Beni-Suef, Egypt Tel: +20201008745118 Fax: +2022327982

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Pet animals, particularly dogs are important companions in many households worldwide; participating to the physical, social and emotional development and the well-being of their owners[1]. However, in spite of the worthy benefits to the society, companion dogs remain a major threat to public health, with dogs harboring several pathogens that can be spread to humans[2]. As communities become more urban, the presence of pets within houses has increased in popularity[3]. Since pet dogs share the same environment with humans and due to their close association with their owners, they play a significant role in the zoonotic transmission routes of the pathogens. Of the zoonotic pathogens acquired from dogs, gastrointestinal parasites are of particular concern as they can cause considerable burdens in humans[4]. As regards zoonotic parasites, *Toxocara canis, Ancylostoma caninum*, *Echinococcus granulosus*, *Dipylidium caninum*, *Entameba histolytica*, *Giardia* spp. and *Cryptosporidium* spp., represent the most popular enteric parasites reported in humans[5-7]. Zoonotic transmission of these parasites occurs either directly by direct contact with infected animal or indirectly by contact with animal feces and contaminated food and water[8]. With the increasing number of pet dogs in the last decades there is more contact between dogs and people, together with a low level of hygienic conditions and lack of sufficient veterinary attention and zoonotic disease awareness compound the risk of transmission of zoonotic gastrointestinal parasites to humans[5]. Nevertheless, only few data are available on the occurrence of intestinal parasites in companion dogs in Egypt. Current information on regional prevalence rates is essential for the development and modification of control measures in animal and public health. The main objective of this study was to determine the prevalence of zoonotic enteric parasites in pet dogs and their human contacts in Cairo and Giza Governorates, Egypt.

MATERIALS AND METHODS

Sampling: A total of 395 fecal samples from pet dogs beside 145 stool samples from humans were collected from Cairo and Giza Governorates, Egypt during the period from July, 2014 to October, 2015.

Dog samples: Fecal samples were collected from household dogs (n = 210) that underwent clinical examination in different veterinary clinics, pet shop dogs (n = 65), beside 120 police dogs obtained from Department of Training Security and Guard Dogs, Police Academy, Cairo. From each dog a fecal sample was collected immediately after defecation and put in a plastic bag then transported to Laboratory of Parasitology Department, Faculty of Veterinary Medicine, Beni-Suef University for parasitological examination. Formalin (10%) was used as preservative for the samples. A questionnaire was used to record the general characteristics of the dogs, including age, gender, breed, type of food eaten, housing condition, presence or absence of diarrhea and history of anthelmintic usage.

Human samples: Stool samples were obtained from both dog owners (n = 100) and pet shop workers (n = 45). Of the sampled individuals, 113 were males and 32 were females. Data concerning age, gender, residence and gastrointestinal complains were recorded using a questionnaire for each person. Each sample was labeled and sent to the laboratory for further parasitological examination.

Laboratory procedures

Macroscopic examination: Feces were stored at 4°C and examined within 48 h. All fecal samples were examined by naked eye for demonstration of adult nematodes and proglottides of tapeworms.

Microscopic examination: Each sample was subjected for examination by centrifugal fecal floatation technique using different solutions (saturated salt solution, zinc sulphate and Sheather's solution) according to Zajac and Conboy[9]. Furthermore, formol ether sedimentation technique[10] was applied for each sample. Lugol's iodine solution was used to facilitate identification of protozoal cysts and trophozoites. Also, Modified Ziehl-Neelsen (MZN) stain was used to detect *Cryptosporidium* spp., oocyst in the examined samples[11]. Parasite eggs, oocysts and cysts were identified under light microscope based on color, shape and contents according to the key given by Soulsby[12].

RESULTS

Prevalence of enteric parasites in the examined dogs: The overall prevalence of enteric parasites in the examined pet dogs was 25.6%, with the police dogs showed the highest prevalence (43.3%) followed by pet shop dogs (30.8%) and finally household dogs (13.8%) (Table 1). The recovered helminths eggs were found belonging to *Trichuris vulpis* (3.3%), *Toxascaris leonina* (5.8%) and *Toxocara canis* (0.3%), whereas the detected protozoa were *Cryptosporidium* spp. (10.1%), *Giardia* spp. (0.5%) and *Entamoeba histolytica/Entamoeba dispar* (5.6%).

Table 1: Prevalence of enteric parasites in the examined dogs

	Examined dogs							
	Household dogs (n = 210)		Police dogs (n = 120)		Pet shop dogs (n = 65)		Total (n = 395)	
Recovered parasite	Positive	%	Positive	%	Positive	%	Positive	%
Trichuris vulpis	3	1.4	5	4.2	5	7.7	13	3.3
Toxascaris leonina	7	3.3	11	9.2	5	7.7	23	5.8
Toxocara canis	0	0.0	0	0	1	1.5	1	0.3
Cryptosporidium spp.	13	6.2	21	17.5	6	9.2	40	10.1
Giardia spp.	0	0.0	2	1.0	0	0.0	2	0.5
Entamoeba histolytica/Entamoeba dispar	6	2.9	13	6.2	3	4.6	22	5.6
Total	29	13.8	52	43.3	20	30.8	101	25.6

Table 2: Risk factors associated with enteric parasites prevalence in the examined dogs (n = 395)

Variables	Risk factor	No. of examined	No. of positive	Positive (%)
Age	<6 months	70	45	64.3
	>6-12 months	125	17	13.6
	>12 months	200	39	19.5
Gender	Male	202	45	22.3
	Female	193	56	29.0
Breed	Local	30	11	36.7
	Exotic	365	90	24.7
Feeding	Dry	290	61	21.0
	Uncooked	105	40	38.1
Housing	Outdoor	185	72	38.9
	Household	210	29	13.8
Health status	Diarrheic	35	20	57.1
	Non-diarrheic	360	81	22.5
Anthelmintic	Regular	255	22	8.6
status	irregular	140	79	56.4

Risk factors associated with enteric parasites prevalence in the examined dogs: Analysis of the risk factors associated with increased prevalence of enteric parasites in the examined dogs revealed that puppies under 6 months of age showed the highest enteric parasite prevalence (64.3%) compared with the other age groups. Concerning the gender, it was found that females has a higher infection rate (29%) compared with males (22.3%). Local breeds exhibited a higher prevalence (36.7%) than exotic ones (24.7%). Also the parasite prevalence was higher in diarrheic dogs (57.1%) than non-diarrheic ones (22.5%). In addition, undercooked feeding, outdoor housing and irregular de-worming were found to be attributed to high prevalence of endoparasites in the examined dogs (Table 2).

Prevalence and risk factors associated with zoonotic enteric parasites in the examined humans: Out of 145 humans, 30 (20.7%) were found positive for enteric parasites (Table 3). The isolated parasites were found belonging to species of *Cryptosporidium* (10.1%), *Giardia* (2.8%) and *Entamoeba hystolytica/Entamoeba dispar* (7.6%). Children in the age group between 5-10 years old showed the highest prevalence of endoparasites. The parasite prevalence in pet shop workers was higher than in households, 27.3 and 16.7% respectively. The study also indicated that males were nearly equal females in the prevalence of enteric parasites (20.4 vs. 21.9%). Finally, individuals with gastrointestinal complains exhibited higher prevalence than those without gastrointestinal complains; 13.3 and 7.6% respectively.

DISCUSSION

The coproscopical examination revealed that the overall prevalence of enteric parasites in the examined pet dogs was 25.6%, a result which is supported by the finding of Ahmed *et al.*[13] who reported that 18.3% of the examined house and police dogs in Alexandria, Egypt were harbored enteric parasites. Similar result (26.9%) was obtained by Gracenea *et al.*[14] in the examined dogs in Spain. Contrary to this finding Fok *et al.*[15] reported that the total infection rate in owned dogs in northern and eastern region of Hungary was 57.8%. Also, Villeneuve *et al.*[16] found that the gastrointestinal parasites infection rate in the examined dogs was 33.9%. Worldwide, it has been found that the prevalence of intestinal parasites in dog range from 16.5% (Canada) to 90% (Sri Lanka)[6,17]. It can vary widely, based in part on geographical location, host individual features, management, sampling protocols, demographic factors, anthelmintic usage and diagnostic techniques[18]. Further, canine helminths are susceptible to the effects of environmental condition and to climate change due to their developmental stages and their survival periods in the environment[19,20].

Trichuris vulpis represented 2.5% of recovered parasites which is nearly similar to that (2%) reported by Sarvi *et al.*[21]. However, a higher prevalence (18.8%) was reported by Alvarado-Esquive *et al.*[22] in shelter dogs in Veracruz, Mexico. The zoonotic potential of *T. vulpis* was supported by Dunn *et al.*[23] who recorded a case of human infection with this worm in a woman with duodenal ulcer disease, chronic diarrhea and close contact

Table 3: Prevalence and risk factors associated with zoonotic enteric parasites in the examined humans (n = 145)

				Recovered parasites					
				Cryptosporidium spp.		*Giardia* spp.		*Entamoeba histolytica* and *Entamoeba dispar*	
Variable and risk factor	No. of examined	No. of positive	Positive (%)	No. of positive	Positive (%)	No. of positive	Positive (%)	No. of positive	Percentage
Age (years)									
5-10	20	12	60.0	8	40.0	1	5.0	3	15.0
11-30	85	19	22.4	7	8.2	3	3.5	6	7.1
>30	40	3	7.5	0.0	0.0	0	0.0	2	5.0
Gender									
Males	113	23	20.4	11	9.7	3	2.7	9	8.0
Females	32	7	21.9	4	12.5	1	3.1	2	6.3
Residence									
Households	90	15	16.7	7	7.8	2	2.2	6	6.7
Pet shop workers	55	15	27.3	8	14.5	2	3.6	5	9.1
Gastrointestinal complains									
Present	15	4	26.7	1	6.7	1	6.7	2	13.3
Absent	130	26	20.0	14	10.8	3	2.3	9	6.9
Total	145	30	20.7	15	10.3	4	2.8	11	7.6

with dogs. Also, Marquez-Navarro *et al*.[24] reported a case of child infection with rhinitis due to *T. vulpis*. However, clear data still need to be provided to definitively add *Trichuris vulpis* to the causes of human intestinal infections[25].

Toxascaris leonina was detected at a rate of 5.8% which is higher than that (3%) reported by Villeneuve *et al*.[16]. Contrary to this finding, a higher percentage (13%) was recorded by Kim and Huh[26]. Also, Beiromvand *et al*.[27] found *Toxascaris leonina* to be the most frequent ascarid identified in dog feces while Mateus *et al*.[28] found it to be the least frequent. It seems that *Toxascaris leonina* does not display zoonotic potential. However, a case of osteomyositis with cutaneous abscesses containing worms identified as *Toxascaris leonina* has been described in the 1960's in the former USSR[29] and also another case of ocular infection by a suspected *Toxascaris* spp., larva has been described from Africa[30].

Even though high prevalence of *T. canis* in dogs in several countries allover the world, this nematode parasite was detected in only one sample (0.3%) that obtained from a pet shop dog. However, Ahmed *et al*.[13] detected *T. canis* in both police and house dogs at a rate 0.8 and 5% respectively, whereas Sarvi *et al*.[21] detected *T. canis* in domestic dogs in Iran at a rate of 27%. Infection of human by *Toxocara* spp., has worldwide distribution and appears in variable frequencies, depending on local factors such as close contact with soil contaminated by dog[31] or dog hair[32]. The zoonotic ability of *Toxocara* spp., has been established and it is well known that pet ascarids cause human infections globally as demonstrated by several surveys carried out in all corners of the World[10,33].

As regards *Cryptosporidium* spp., they were detected at a rate of 10.1% in the examined dogs. Nearly similar result (7.8%) was recorded by Ngui *et al*.[34] in rural dogs in Malaysia, whereas lower percentages (3%) and (3.3%) have been reported by Villeneuve *et al*.[16] and Giangaspero *et al*.[35] in Canada and Italy respectively. Regarding humans, *Cryptosporidium* oocysts were detected a rate of 10.3%; with children of 5-10 years old were more affected (40%). This is in agreement with many studies carried out in individuals of various ages in several areas of Egypt that denote the prevalence of cryptosporidiosis in humans varied[36] between 0 and 47%. Also, Mukhopadhyay *et al*.[37] reported a high prevalence of cryptosporidiosis in young children, especially those aged less than 2 years. The zoonotic potential of *Cryptosporidium* has been proved by Sargent *et al*.[38] who denoted that dogs act as a potential source of zoonotic cryptosporidiosis. Several reports indicated that *Cryptosporidium canis* is present in human patients in the United Kingdom, Kenya, Peru, Thailand and the United States[39,40]. Although, a recent study suggested that cryptosporidiosis from pet dogs poses only a minimal zoonotic risk, the possible public-health implications of *C. canis* cannot be ignored[41]. Even though a small number of humans are infected with *C. canis*, recent findings of concurrent *C. hominis* infection in *C. canis* infected persons suggest that many of the *C. canis* infections in humans may be due to anthroponotic rather than zoonotic transmission[42].

The results of the present study showed that *Giardia* was less frequent (0.5%) than *Cryptosporidium* in the examined dogs. Contrary to this result[43] found that *Giardia* was the most frequent among intestinal protozoa whereas *Cryptosporidium* was less common in the canine fecal samples. Also in a study conducted in Australia, *Giardia* was found to be the most prevalent parasite in healthy pet dogs (9.4%) whereas

Cryptosporidium was detected at much lower rate[44] (0.6%). In Portugal, Neves *et al.*[45] reported the prevalence of *Giardia* spp., in 7.4% of apparently healthy dogs and in 15.5% of those suffered from gastrointestinal disease. Besides, Alvarado-Esquive *et al.*[22] identified *Giardia* spp., in dogs at much higher levels (45.5%). Recent surveys of gastrointestinal parasites of dogs have demonstrated high levels (prevalence of 7.2-22.1%) of *Giardia* in stray as well as domestic dogs in both developing and developed countries[17,46]. Concerning humans, *Giardia* spp., were detected at a rate of 2.8% (Table 3). In developing countries, *Giardia* prevalence in humans fell[47-52] into the range of 8-30%. On the other hand, lower prevalence rates were reported in Germany[53] (1.5%), Italy[54] (0.4-6.2%), United Kingdom[55] (1.3%) and United States[56] (1.4%). Several studies denoted that dogs can harbor zoonotic assemblage (Assemblage A) of *Giardia*[57,58]. Also, the presence of genetically similar isolates in humans and dogs from different geographical locations worldwide has provided circumstantial evidence in support of *Giardia* (*G. duodenalis*) being zoonotic[59,60]. However, the facility of genotyping Giardia is not readily available to veterinarians in practice; consequently all positives should be assumed zoonotic. Therefore, treatment is necessary regardless of whether the animals asymptomatic, given the zoonotic potential of this parasite and because they are a source of infection for other animals[61].

Entamoeba histolytica/Entamoeba dispar were detected in the examined dogs at a rate of 5.6% while in humans the prevalence was 7.6%. Because it is impossible to differentiate pathogenic *E. histolytica* from non-pathogenic *Entamoeba dispar*, using light microscopy[62], all cysts morphologically consistent with *E. histolytica* were referred to as *E. histolytica/Entamoeba dispar* to reflect this uncertainty. In a study carried out in Alexandria Governorate, Egypt, *E. histolytica/Entamoeba dispar* was recovered in a rate of 18.3% from the examined dogs[13]. Also, Alam *et al.*[63] in Lahore, Pakistan, isolated *E. histolytica* like cyst from housed and clinically diseased dogs in a percentage of 15.6 and 95%, respectively. They added that dogs play an important role in the epidemiology of *Entamoeba* infection in endemic areas. Human amoebiasis was reported at a higher rate (14.4%) in Beni-Suef Governorate, Egypt from diarrheic and/or dysenteric patients[64]. Also, in a study by Aza *et al.*[65] in Malaysia, amoebiasis was reported in humans at prevalence of 21.0%. On the other hand, Al-Harthi and Jamjoom[66] reported 2.6% prevalence of *E. histolytica* infection in Makah, Saudi Arabia. Accuratestrain-specific diagnosis of *E. histolytica* would help in the generation of accurate epidemiological data for a better estimate of the burden of amoebiasis on the health of the world[67]. The just presence of *Entamoeba* cysts in feces of humans is of low significance, as the Pan American Health Organization does not recommend treatment to asymptomatic individuals presenting cysts of *Entamoeba histolytica/Entamoeba dispar* in stools without the specific identification of *E. histolytica*[68]. It is worth mentioning that close contact with pet dogs was associated with an increased risk of contracting *Entamoeba*, this might be due to that cysts of *Entamoeba* are deposited on the surface (fur) of the animals during close contact with humans and then later transmitted to a next person[69]. Finally, the presence of enteric parasites in the studied population demonstrates that the poor hygienic conditions, important risk factor of fecal-oral transmission, were not improved in the community.

Generally the lower prevalence of enteric parasites (especially helminths) in household dogs (13.8%) as compared to both police (43.3%) and pet shop (30.8%) dogs reported in this study might be attributed to the regular deworming of pet dogs using (pyrantal, febental and praziquental) and to the general hygienic measures applicable to the household dogs. Also, it might reflect the highest risk of parasitic infections and consequently environmental contamination and transmission of enteric parasites through the fecal-oral route more frequently in outdoor dogs[70].

It is worth mentioning that all the estimated parasites either helminths or protozoa have a direct life cycle. The animals investigated were housed under captivity so the chances for harboring cestodes or trematodes, which require an intermediate host were limited. In spite of hygienic measures, regular deworming and high quality of feeding, a range of different parasites were reported in this work. The relative high prevalence of intestinal parasites recorded reflects that even with relatively high level of care, companion dogs may act as a potential source for environmental contamination with such parasites and the potentiality of other animals as well as humans to be infected.

Analysis of risk factors associated with parasitic infection revealed that puppies under 6 months of age showed the highest enteric parasite prevalence (64.3%) compared with the other age groups. Abere *et al.*[71] reported that the overall prevalence of parasites was significantly higher in young dogs (<1 year) than adults. This was partially due to parasite specific immunity usually acquired with age or probably as a consequence of single or repeated exposures[72]. However, it is nowadays established that patent intestinal infections occur in dogs of all ages[73].

Concerning the gender, it was found that females has a higher infection rate (29%) compared with males (22.3%) which in accordance with Davoust *et al.*[74] in Nigeria who

concluded that female dogs were more liable to contract intestinal nematodes than males. In contrast Getahun and Addis[75] reported that the prevalence rate of enteric parasites was higher in male than female dogs (79.2 vs. 76.8%). However, Alvarado-Esquive[22] found that the overall prevalence of parasitic infections in dogs did not vary with sex.

Local breeds of dogs were found to harbor more enteric parasites (36.7%) than exotic breeds (24.7%). In accordance with this finding, Getahun and Addis[75] reported that the exotic breeds were more likely to contract infection. On the other hand Swai *et al.*[76] in Tanzania and Shukllari *et al.*[77] in Albania documented that breed was not a risk factor for parasitic infection in dogs and all breeds have equal opportunity to contract the infection if exposed to the same source. The association of enteric parasite infection with local breeds is probably due to differences in healthcare received, in comparison with pure breeds, where pure breed dogs generally receive better care, including deworming and access to clean food and water[78].

Dogs kept outdoor (police and pet shop dogs) exhibited a higher prevalence of enteric parasites (38.9%) compared with those kept as households (13.8%). This is in accordance with Katagiri and Oliveira-Sequeira[18] and Zanzani *et al.*[78] who found that cohabitation with other dogs is one of the most important risk factors associated to endoparasitism. This might be attributed to that the presence of multiple dogs outdoor makes them more susceptible to infection with more environmental contamination.

Irregular deworming was found to be a contributing factor in the increasing prevalence of parasitic infection in dogs as 49 (56.4%) out of 156 dogs irregularly receiving anthelmintic drugs were harbored enteric parasite compared to 22 (8.6%) out of 255 dogs receiving anthelmintic regularly. While the increased awareness and controlling of dog parasites reduce the likelihood of environmental contamination and zoonotic transmission, irregular deworming without targeting of particular parasite were considered to be of less affectivity and increasing the drug resistance[79]. It is worth mentioning that a treatment frequency of at least 4 times per year or even a monthly treatment, are general recommendations according to different scenarios, e.g., real zoonotic risks, presence of children in the pet owners family, pregnancy of bitch and housing conditions[80].

CONCLUSION

On conclusion, parasitological results in this study clearly highlight the significant role of pet dogs as a host for several species of enteric parasites; therefore preventive measures should be taken to avoid the environmental contamination and infection of both man and animals.

REFERENCES

1. Wong, S.K., L.H. Feinstein and P. Heidmann, 1999. Healthy pets, healthy people. J. Am. Vet. Med. Assoc., 215: 335-338.
2. Robertson, I.D., P.J. Irwin, A.J. Lymbery and R.C.A. Thompson, 2000. The role of companion animals in the emergence of parasitic zoonoses. Int. J. Parasitol., 30: 1369-1377.
3. Overgaauw, P.A.M., L. van Zutphen, D. Hoek, F.O. Yaya and J. Roelfsema *et al.*, 2009. Zoonotic parasites in fecal samples and fur from dogs and cats in the Netherlands. Vet. Parasitol., 163: 115-122.
4. Torgerson, P.R. and C.N. Macpherson, 2011. The socioeconomic burden of parasitic zoonoses: Global trends. Vet. Parasitol., 182: 79-95.
5. Chen, J., M.J. Xu, D.H. Zhou, H.Q. Song and C.R. Wang and X.Q. Zhu, 2012. Canine and feline parasitic zoonoses in China. Parasit. Vectors, Vol. 5. 10.1186/1756-3305-5-152.
6. Perera, P.K., R.P.V.J. Rajapakse and R.S. Rajakaruna, 2013. Gastrointestinal parasites of dogs in Hantana area in the Kandy District. J. Natl. Sci. Foundation Sri Lanka, 41: 81-91.
7. Satyal, R.C., S. Manandhar, S. Dhakal, B.R. Mahato, S. Chaulagain, L. Ghimire and Y.R. Pandeya, 2013. Prevalence of gastrointestinal zoonotic helminths in dogs of Kathmandu, Nepal. Int. J. Infect. Microbiol., 2: 91-94.
8. Martinez-Moreno, F.J., S. Hernandez, E. Lopez-Cobos, C. Becerra, I. Acosta and A. Martinez-Moreno, 2007. Estimation of canine intestinal parasites in Cordoba (Spain) and their risk to public health. Vet. Parasitol., 143: 7-13.
9. Zajac, A.M. and G.A. Conboy, 2006. Veterinary Clinical Parasitology. 7th Edn., Blackwell Publishing, UK., ISBN-13: 978-0813817347, Pages: 320.
10. Lee, J.L., S.J. Kang, N.A. Kim, C.W. Lee and K.H. Ahn *et al.*, 2010. Investigation of helminths and protozoans infecting old world monkeys: Captive vervet, cynomolgus and rhesus monkeys. Korean J. Vet. Res., 50: 273-277.
11. Henriksen, S.A. and J.F. Pohlenz, 1981. Staining of cryptosporidia by a modified Ziehl-Neelsen technique. Acta Veterinaria Scandinavica, 22: 594-596.
12. Soulsby, E.J.L., 1982. Helminths, Arthropods and Protozoa of Domesticated Animals. 7th Edn., Bailliere Tindall, London, UK., ISBN-13: 9780702008207, Pages: 809.
13. Ahmed, W.M., W.M. Mousa, S.M. Aboelhadid and M.M. Tawfik, 2014. Prevalence of zoonotic and other gastrointestinal parasites in police and house dogs in Alexandria, Egypt. Vet. World, 7: 275-280.
14. Gracenea, M., M.S. Gomez and J. Torres, 2009. Prevalence of intestinal parasites in shelter dogs and cats in the metropolitan area of Barcelona (Spain). Acta Parasitologica, 54: 73-77.

15. Fok, E., V. Szatmari, K. Busak and F. Rozgonyi, 2001. Epidemiology: Prevalence of intestinal parasites in dogs in some urban and rural areas of Hungary. Vet. Quart., 23: 96-98.
16. Villeneuve, A., L. Polley, E. Jenkins, J. Schurer and J. Gilleard *et al*., 2015. Parasite prevalence in fecal samples from shelter dogs and cats across the Canadian provinces. Parasit. Vectors, Vol. 8. 10.1186/s13071-015-0870-x
17. Joffe, D., D. van Niekerk, F. Gagne, J. Gilleard, S. Kutz and R. Lobingier, 2011. The prevalence of intestinal parasites in dogs and cats in Calgary, Alberta. Can. Vet. J., 52: 1323-1328.
18. Katagiri, S. and T.C.G. Oliveira-Sequeira, 2008. Prevalence of dog intestinal parasites and risk perception of zoonotic infection by dog owners in Sao Paulo State, Brazil. Zoonoses Public Health, 55: 406-413.
19. Polley, L. and R.C.A. Thompson, 2009. Parasite zoonoses and climate change: Molecular tools for tracking shifting boundaries. Trends Parasitol., 25: 285-291.
20. Jenkins, E.J., J.M. Schurer and K.M. Gesy, 2011. Old problems on a new playing field: Helminth zoonoses transmitted among dogs, wildlife and people in a changing Northern climate. Vet. Parasitol., 182: 54-69.
21. Sarvi, S., A. Daryani, M. Sharif, M.T. Rahimi and D. Azami *et al*., 2014. Domestic dog as a human health hazard in north of Iran. J. Parasitic Dis. 10.1007/s12639-014-0608-2.
22. Alvarado-Esquive, C., D. Romero-Salas, M. Aguilar-Dominguez, A. Cruz-Romero, N. Ibarra-Priego and A.A. Perez-de-Leon, 2015. Epidemiological assessment of intestinal parasitic infections in dogs at animal shelter in Veracruz, Mexico. Asian Pac. J. Trop. Biomed., 5: 34-39.
23. Dunn, J.J., S.T. Columbus, W.E. Aldeen, M. Davis and K.C. Carroll, 2002. *Trichuris vulpis* recovered from a patient with chronic diarrhea and five dogs. J. Clin. Microbiol., 40: 2703-2704.
24. Marquez-Navarro, A., G. Garcia-Bracamontes, B.E. Alvarez-Fernandez, L.P. Avila-Caballero and I. Santos-Aranda *et al*., 2012. *Trichuris vulpis* (Froelich, 1789) infection in a child: A case report. Korean J. Parasitol., 50: 69-71.
25. Traversa, D., 2011. Are we paying too much attention to cardio-pulmonary nematodes and neglecting old-fashioned worms like *Trichuris vulpis*? Parasit. Vectors, Vol. 8. 10.1186/1756-3305-4-32.
26. Kim, Y.H. and S. Huh, 2005. Prevalence of *Toxocara canis*, *Toxascaris leonina* and *Dirofilaria immitis* in dogs in Chuncheon, Korea (2004). Korean J. Parasitol., 43: 65-67.
27. Beiromvand, M., L. Akhlaghi, S.H.F. Massom, A.R. Meamar, A. Motevalian, H. Oormazdi and E. Razmjou, 2013. Prevalence of zoonotic intestinal parasites in domestic and stray dogs in a rural area of Iran. Prev. Vet. Med., 109: 162-167.
28. Mateus, T.L., A. Castro, J.N. Ribeiro and M. Vieira-Pinto, 2014. Multiple zoonotic parasites identified in dog feces collected in Ponte de Lima, Portugal-a potential threat to human health. Int. J. Environ. Res. Public Health, 11: 9050-9067.
29. Grinberg, A.I., 1961. Rare cases of *Toxascaris leonina* and *Toxocara mystax* in man. Meditsinskaya Parazitologiya Parazitarnye Bolezni, 30: 626-626.
30. Beaver, P.C. and D.D. Bowman, 1984. Ascaridoid larva (Nematoda) from the eye of a child in Uganda. Am. J. Trop. Med. Hyg., 33: 1272-1274.
31. Itoh, N., K. Kanai, Y. Hori, F. Hoshi and S. Higuchi, 2009. Prevalence of *Giardia intestinalis* and other zoonotic intestinal parasites in private household dogs of the Hachinohe area in Aomori prefecture, Japan in 1997, 2002 and 2007. J. Vet. Sci., 10: 305-308.
32. Keegan, J.D. and C.V. Holland, 2013. A comparison of *Toxocara canis* embryonation under controlled conditions in soil and hair. J. Helminthol., 87: 78-84.
33. Despommier, D., 2003. Toxocariasis: Clinical aspects, epidemiology, medical ecology and molecular aspects. Clin. Microbiol. Rev., 16: 265-272.
34. Ngui, R., S.C. Lee, N.J. Yap, T.K. Tan and R.M. Aidil *et al*., 2014. Gastrointestinal parasites in rural dogs and cats in Selangor and Pahang States in Peninsular Malaysia. Acta Parasitologica, 59: 737-744.
35. Giangaspero, A., R. Iorio, B. Paoletti, D. Traversa and G. Capelli, 2006. Molecular evidence for *Cryptosporidium* infection in dogs in Central Italy. Parasitol. Res., 99: 297-299.
36. Abd El Kader, N.M., M.A. Blanco, M. Ali-Tammam, A.E.R.B. Abd El Ghaffar and A. Osman *et al*., 2012. Detection of *Cryptosporidium parvum* and *Cryptosporidium hominis* in human patients in Cairo, Egypt. Parasitol. Res., 110: 161-166.
37. Mukhopadhyay, C., G. Wilson, D. Pradhan and P.G. Shivananda, 2007. Intestinal protozoal infestation profile in persistent diarrhea in children below age 5 years in Western Nepal. Southeast Asian J. Trop. Med. Public Health, 38: 13-19.
38. Sargent, K.D., U.M. Morgan, A. Elliot and R.C.A. Thompson, 1998. Morphological and genetic characterisation of *Cryptosporidium oocysts* from domestic cats. Vet. Parasitol., 77: 221-227.
39. Fayer, R., 2010. Taxonomy and species delimitation in *Cryptosporidium*. Exp. Parasitol., 124: 90-97.
40. Elwin, K., S.J. Hadfield, G. Robinson and R.M. Chalmers, 2012. The epidemiology of sporadic human infections with unusual *Cryptosporidia* detected during routine typing in England and Wales, 2000-2008. Epidemiol. Infect., 140: 673-683.
41. Bowman, D.D. and A. Lucio-Forster, 2010. Cryptosporidiosis and giardiasis in dogs and cats: Veterinary and public health importance. Exp. Parasitol., 124: 121-127.
42. Cama, V., R.H. Gilman, A. Vivar, E. Ticona, Y. Ortega, C. Bern and L. Xiao, 2006. Mixed *Cryptosporidium* infections and HIV. Emerg. Infect. Dis., 12: 1025-1028.
43. Rinaldi, L., M.P. Maurelli, V. Musella, V. Veneziano and S. Carbone *et al*., 2008. *Giardia* and *Cryptosporidium* in canine faecal samples contaminating an urban area. Res. Vet. Sci., 84: 413-415.

44. Palmer, C.S., R.C.A. Thompson, R.J. Traub, R. Rees and I.D. Robertson, 2008. National study of the gastrointestinal parasites of dogs and cats in Australia. Vet. Parasitol., 151: 181-190.
45. Neves, D., L. Lobo, P.B. Simoes and L. Cardoso, 2014. Frequency of intestinal parasites in pet dogs from an urban area (Greater Oporto, Northern Portugal). Vet. Parasitol., 200: 295-298.
46. Gates, M.C. and T.J. Nolan, 2009. Endoparasite prevalence and recurrence across different age groups of dogs and cats. Vet. Parasitol., 166: 153-158.
47. Chaves, M.D.P., J.A. Fernandez, I. Ospina, M.C. Lopez, L. Moncada and P. Reyes, 2007. *Giardia duodenalis* prevalence and associated risk factors in preschool and school-age children of rural Colombia. Biomedica, 27: 345-351.
48. Dib, H.H., S.Q. Lu and S.F. Wen, 2008. Prevalence of *Giardia lamblia* with or without diarrhea in South East, South East Asia and the Far East. Parasitol. Res., 103: 239-251.
49. Londono, A.L., S. Mejia and J.E. Gomez-Marin, 2009. Prevalence and risk factors associated with intestinal parasitism in preschool children from the urban area of Calarca, Colombia. Revista Salud Publica, 11: 72-81.
50. Maia, M.M.M., M.A. Fausto, E.L.M. Vieira, M.L.F.N. Benetton and M. Carneiro, 2009. Intestinal parasitic infection and associated risk factors, among children presenting at outpatient clinics in Manaus, Amazonas State, Brazil. Ann. Trop. Med. Parasitol., 103: 583-591.
51. Siwila, J., I.G.K. Phiri, H.L. Enemark, M. Nchito and A. Olsen, 2010. Intestinal helminths and protozoa in children in pre-schools in Kafue district, Zambia. Trans. R. Soc. Trop. Med. Hyg., 104: 122-128.
52. Al-Mohammed, H.I., 2011. Genotypes of *Giardia intestinalis* clinical isolates of gastrointestinal symptomatic and asymptomatic Saudi children. Parasitol. Res., 108: 1375-1381.
53. Sagebiel, D., T. Weitzel, K. Stark and K. Leitmeyer, 2009. Giardiasis in kindergartens: Prevalence study in Berlin, Germany, 2006. Parasitol. Res. Vol. 105. 10.1007/s00436-009-1438-5.
54. Giangaspero, A., F. Berrilli and O. Brandonisio, 2007. *Giardia* and *Cryptosporidium* and public health: The epidemiological scenario from the Italian perspective. Parasitol. Res., 101: 1169-1182.
55. Davies, A.P., B. Campbell, M.R. Evans, A. Bone, A. Roche and R.M. Chalmers, 2009. Asymptomatic carriage of protozoan parasites in children in day care centers in the United kingdom. Pediatr. Infect. Dis. J., 28: 838-840.
56. Church, C., A. Neill and A.M. Schotthoefer, 2010. Intestinal infections in humans in the Rocky Mountain region, United States. J. Parasitol., 96: 194-196.
57. Caccio, S.M., R.C.A. Thompson, J. McLauchlin and H.V. Smith, 2005. Unravelling *Cryptosporidium* and *Giardia* epidemiology. Trends Parasitol., 21: 430-437.
58. Leonhard, S., K. Pfister, P. Beelitz, C. Wielinga and R.C.A. Thompson, 2007. The molecular characterisation of *Giardia* from dogs in Southern Germany. Vet. Parasitol., 150: 33-38.
59. O'Handley, R.M., M.E. Olson, D. Fraser, P. Adams and R.C.A. Thompson, 2000. Prevalence and genotypic characterisation of *Giardia* in dairy calves from Western Australia and Western Canada. Vet. Parasitol., 90: 193-200.
60. Graczyk, T.K., J. Bosco-Nizeyi, B. Ssebide, R.C.A. Thompson, C. Read and M.R. Cranfield, 2002. Anthropozoonotic *Giardia duodenalis* genotype (assemblage) a infections in habitats of free-ranging human-habituated gorillas, Uganda. J. Parasitol., 88: 905-909.
61. Palmer, C.S., R.J. Traub, I.D. Robertson, G. Devlin, R. Rees and R.C.A. Thompson, 2008. Determining the zoonotic significance of *Giardia* and *Cryptosporidium* in Australian dogs and cats. Vet. Parasitol., 154: 142-147.
62. Packers, J., 2002. The diagnostic implications of the separation of *Entamoeba histolytica* and *Entamoeba dispar*. J. Biosci., 27: 573-578.
63. Alam, M.A., A. Maqbool, M.M. Nazir, M. Lateef, M.S. Khan and D.S. Lindsay, 2015. *Entamoeba* infections in different populations of dogs in an endemic area of Lahore, Pakistan. Vet. Parasitol., 207: 216-219.
64. Ibrahim, S.S., O.M. El-Matarawy, M.A. Ghieth, E.Y. Abu Sarea and A.Y. El-Badry, 2015. Copro prevalence and estimated risk of *Entamoeba histolytica* in Diarrheic patients at Beni-Suef, Egypt. World J. Microbiol. Biotechnol., 31: 385-390.
65. Aza, N., S. Ashley and J. Albert, 2003. Parasitic infection in human communities living on the fingers of the Crocker range park, Sabah, Malaysia. ASEAN Review of Biodiversity and Enviromental Conservation (ARBEC). http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.548.846&rep=rep1&type=pdf.
66. Al-Harthi, S.A. and M.B. Jamjoom, 2007. Diagnosis and differentiation of *Entamoeba* infection in Makkah Al Mukarramah using microscopy and stool antigen detection kits. World J. Med. Sci., 2: 15-20.
67. Petri, Jr. W.A., R. Haque, D. Lyerly and R.R. Vines, 2000. Estimating the impact of amebiasis on health. Parasitol. Today, 16: 320-321.
68. World Health Organization, 1997. Amoebiasis. Weekly Epidemiol. Records, 72: 97-99.
69. Duc, P.P., H. Nguyen-Viet, J. Hattendorf, J. Zinsstag, P.D. Cam and P. Odermatt, 2011. Risk factors for *Entamoeba histolytica* infection in an agricultural community in Hanam province, Vietnam. Parasit. Vectors, Vol. 4. 10.1186/1756-3305-4-102.
70. Chomel, B.B., 2008. Control and prevention of emerging parasitic zoonoses. Int. J. Parasitol., 38: 1211-1217.
71. Abere, T., B. Bogale and A. Melaku, 2013. Gastrointestinal helminth parasites of pet and stray dogs as a potential risk for human health in Bahir Dar town, North-Western Ethiopia. Vet. World, 6: 388-392.

72. Ramirez-Barrios, R.A., G. Barboza-Mena, J. Munoz, F. Angula-Cubillan, E. Hernandez, F. Gonzalez and F. Escalona, 2004. Prevalence of intestinal parasites in dogs under veterinary care in Maracaibo, Venezula. Vet. Parasitol., 121: 11-20.
73. Barutzki, D. and R. Schaper, 2011. Results of parasitological examinations of faecal samples from cats and dogs in Germany between 2003 and 2010. Parasitol. Res., 109: 45-60.
74. Davoust, B., T. Normand, O. Bourry, H. Dang, E. Leroy and G. Bourdoiseau, 2008. Epidemiological survey on gastro-intestinal and blood-borne helminths of dogs in North-East Gabon. Onderstepoort J. Vet. Res., 75: 359-364.
75. Getahun, Z. and M. Addis, 2012. Prevalence of gastrointestinal helminths among dogs in Bahir Dar town, Ethiopia. World Applied Sci. J., 19: 595-601.
76. Swai, E.S., E.J. Kaaya, D.A. Mshanga and E.W. Mbise, 2010. A survey on gastro-intestinal parasites of non-descript dogs in and around Arusha Municipality, Tanzania. Int. J. Anim. Vet. Adv., 3: 63-67.
77. Shukullari, E., D. Hamel, D. Rapti, K. Pfister, M. Visser, R. Winter and S. Rehbein, 2015. Parasites and vector-borne diseases in client-owned dogs in Albania. Intestinal and pulmonary endoparasite infections. Parasitol. Res., 114: 4579-4590.
78. Zanzani, S.A., A.L. Gazzonis, P. Scarpa, F. Berrilli and M.T. Manfredi, 2014. Intestinal parasites of owned dogs and cats from metropolitan and micropolitan areas: Prevalence, zoonotic risks and pet owner awareness in northern Italy. BioMed Res. Int., Vol. 2014. 10.1155/2014/696508.
79. Coles, G.C., 1995. Chemotherapy of human nematodes: Learning from the problems in sheep. J. R. Soc. Med., 88: 649P-651P.
80. Epe, C., 2009. Intestinal nematodes: Biology and control. Vet. Clin. North Am.: Small Anim. Pract., 39: 1091-1107.