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Original article

Prevalence and associated risk factors of *Toxocara* infection in dogs in northern and southern Egypt

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ABSTRACT

Toxocariasis is a zoonotic disease with a worldwide distribution caused by the parasitic roundworms, *Toxocara canis*, commonly found in the intestine of dogs. Identification of frequent shedders for *Toxocara canis* eggs and the associated risk factors overwhelmingly remain an important cornerstone of conducting evidence-based deworming regimens to reduce the environmental contamination with the parasite eggs. The present study was undertaken to prevalence rate of shedding of *Toxocara canis* eggs in dogs in Egypt combined with the possible risk factors naturally associated with the infection A total number of 296 fecal samples of dogs were collected in the period from July 2016 to June 2017 and properly screened for the presence of possible infection with an. Importantly, The overall prevalence of *Toxocara canis* eggs was 53.04% whereas, seasonal dynamics, dog breeds, the irregular anthelmintic use, defecation sites, and unconfined management of dogs were among the risk factors with a significant association with *Toxocara canis* infection.

Taken together, our present data reveal the high overall prevalence of *Toxocara canis* eggs shedding in in several Egyptian provinces and provide novel information that should pay our attention of the local authorities combined with the public engagement towards implementation of effective control strategies against this disease of zoonotic importance.

1. Introduction

Dogs are the most popular canids that adapted to human habitation worldwide. In addition to being the man's best friends, they unwittingly provide proper socialization, mental health and even physical well-being to their private owners, particularly children (Robertson et al., 2000). However, there are a potential public health hazards associated with the direct ownership of a beloved pet. Besides the possible risk of bites, scratches, and allergies, dogs are the primary reservoirs of many infective stages of zoonotic parasites (Molyneux, 2004). Among others, *Toxocara canis* has been considered a worldwide-distributed parasitic roundworm of canids with high zoonotic potential as it causes visceral and ocular larva migrans and allergic inflammation in humans (Pinelli and Aranzamedi, 2012, and Fillaux and Magnaval, 2013). Dogs naturally acquire the infection through ingestion of embryonated eggs typically contains third stage larvae in contaminated soil, sand, polluted water, feces or contaminated food or after excessive consumption of an infected paratenic host containing Larvae. Additionally, puppies can contract the infection from their mother's uterus during gestation or during nursing through their mothers' milk (Warren, 1969). The artificial contamination of soil inadvertently revealed maximum numbers of free-range *Toxocara* eggs were recovered from clay soil, followed by sawdust, and sand soil after 6 months incubation under moist condition (El-Menyawe and Abdel Rahman, 2007).

In fact, *T. canis* has been considered one the most worldwide-distributed parasitic zoonoses worldwide especially in African which reflects its a high public health significance as it causes human toxocariasis, that considers critical one of most zoonotic parasitic infection worldwide especially in African countries (El-Menyawe and Abdel Rahman, 2007). Contracting the infection in human being is typically occurred by ingestion of embryonated eggs that shed in dog feces. The unusual infection in human is properly called visceral larva migrans,

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which is asymptomatic in most unusual cases, liberated larvae from ingested eggs scarcely penetrate the intestinal mucosa, invade the portal vein, then migrate to various principal organs and encyst, but it cannot sufficiently develop to mature worm (Sariego et al., 2012). In Egypt, stray dogs counts about 2 million found in Greater Cairo Area (General Organization of Veterinary Services, Ministry of Agriculture, Cairo, pers. Comm.) where they properly fed scavenged animal offal's and refuse. In fact, several previous studies were conducted on prevalence of *T. canis* in dogs by (Khalil, 1964) on toxocariasis in the Siwa oasis, and (Ahmed et al., 2014) in Alexandria, Egypt. In the same line, another previous study was carried in Egypt to explore the major zoonotic enteric parasites transmitted from dogs with special concern to *Toxocara canis* in dogs and human (Awadallah and Salem, 2015).

To authors's knowledge, studying the epidemiological pattern of the parasitic diseases in the different agro-climatic zones usually provides a consistent basis for developing properly strategic and careful control systems against them (Traub et al., 2007). Keeping in view the considerable zoonotic importance of *T. canis* infection, the present study was designed to determine the coprological apparent prevalence of *Toxocara canis* and other parasitic infection. We also aimed to properly investigate the possible risk factors for possible acquisition of *Toxocara canis* infection in the canine population in Northern and Southern Egypt.

2. Materials and methods

2.1. Ethical considerations and study area

The study protocol was carefully reviewed and approved by the local guidance of Research, Publication and Ethics of the Faculty of Veterinary Medicine, Sohag University, Egypt on October 14, 2015. Samples were randomly collected from dogs admitted daily to pets' private clinics, and prospective owners were properly notified about the objective of this study and correctly applied a questionnaire concern their beloved pets. A cross-sectional study was carried out in four Egyptian governorates including Alexandrina, Ismailia, Menofia and Sohag (Fig. 1). Alexandrina governorate is conveniently located in the northern part of the distinct country (latitude 31°12′56.3″N, and Longitude 29° 57′ 18.97″E), directly on the Mediterranean Sea, naturally making it one of the most important harbors in Egypt. The local climate of the distinct Alexandria region is one of the mildest of the Mediterranean Sea, with average annual rain is properly 169 mm.

Ismailia governorate represent a principal city in north-eastern Egypt (latitude 30°36′ 15.37″N, and Longitude32°16′20.1″E), with a civil population of 366,669. Its climate was classified as hot desert, while Menofia governorate is typically located in northern part of the local country in Nile Delta (Latitude 30° 565,576″N and Longitude 31°013082″E), with a local population of 3,941,293 and a tropical desert climate. Sohag Governorate is one of rural governorates in upper Egypt (latitude 26°559,074″N and Longitude 31°695,671″W), climatically, the year fall into two distinct parts, a cool winter from November to April, and a hot summer from May to October with average annual rainfall is precisely 1 mm.

2.2. Animals and epidemiological achievement

A total number of 296 dogs' fecal samples were typically collected from four Egyptian governorates, Alexandria, Ismailia, Menofia and Sohag, in the period between July 2016 and June 2017. The samples were then submitted to the laboratories of Departments of Parasitology and Zoology, Faculty of Veterinary Medicine - Sohag University and Faculty of Science Damanhur University for coprological screening of *Toxocara canis* eggs and any other parasitic infections. The composed samples were preserved in formalin 10% and stored in closed containers at 4 °C. Additionally, aweb-based self-administered questionnaire was completed to merely collect relevant epidemiological information. The questionnaire was in Arabic and included information concerning the dog's age, sex, breed, locality, management practice, defecation site, collection date, other parasitic infection, and irregular use of anthelmintic and deworming history. In total, 296 fecal samples from pet clinic and stray dogs were available with their corresponding questionnaire.

2.3. Coprological examination

Fresh fecal samples from were collected individually from pet clinic dogs by rectal examination during veterinary visit while the samples from stray dogs were picked up after defecation in the local street, and properly recognized. Also fecal samples were carefully collected sometimes during defecation at private home houses and sent instantly to the laboratory. Collected samples were examined by routine flotation technique as described elsewhere (Kurse and Pritchard, 1982). Briefly, scant amount of fecal sample nearly 3–5 g was mixed with a saturated Na CL solution (Sp. Gr. 1.2) till a homogenous suspension, filtered by a 60-mesh sieve, suspension was then put in test tubes to the exposed top allegedly covered by a cover glass for 15–20 min. The samples were then properly examined at 10× then 40× magnifications, and the viable eggs were identified by microscopy with possible reference to Soulsby (1986).

2.4. Statistical analysis

Comparative analysis was carried out using Chi-square, binary logistic regression analysis, and odds ratio (OR) tests to confirm the mean differences between local groups and possible association with apparent prevalence (Fleiss, 1981). The appropriate level of logical significance carefully selected was precisely $P < .05$ with an odds ratio > 1.0.

3. Results

Interestingly, the results showed that the overall prevalence of *T. canis* infection among examined dogs was was 53.04% (157/296) As shown in table1, and Chart 1, Sohag province was the highest with (75.4%) prevalence of *T. canis*, followed by Alexandria (49.68%), then Ismailia (47.82%), whereas the lowest infection rate was recorded in exclusive Menofia province (32.14%). Results depicted in Table 1, and Chart 2, revealed that male dogs typically have a higher overall prevalence of *T. canis* infection (51.56%) than female dogs (46.15%).

On the other hand, Table 1 and Chart 3 demonstrated seasonal dynamics of *Toxocara canis* active infection among examined dogs in Egypt. In this line, the highest rate of overwhelming infection was precisely during proper summer season (81.65%), at ($P \leq .05$) significance difference and it is properly considered an associated risk factor (Odd Ratio: 1.052) with confidence interval at (0.823–1.344). Regarding the age factor, Table 1 and chart 4, ultimate results show that; dog's ages between 8 and 24 typical weeks typically have the highest prevalence (54.16%). Prevalence of infection was insignificantly higher in mixed breed dogs.

Regarding the associated risk factors with infection, it is considered a strong associated risk factor for the infection with confidence interval at 95% confidence ratio as shown in Table 1, and Chart 5. As depicted in in Table 1 and Chart 6, there is a strong association between anthelmintic use and apparent prevalence of potential infection with *Toxocara canis* (Odd Ratio: 6.401), confidence interval (4.265–9.606) at 95% confidence. In this line, the local groups that subjected to irregular use of specific drugs assuredly has a significant highest rate of infection with *Toxocara canis* (77.14%) adept at ($P \leq .05$). Regarding to defecation sites as a risk factor, the structured questionnaire revealed precisely that defecation outside is considered strong associated risk factor for infection, in which dogs defecate outside has the highest infection rate with 54.82%, that it was statistically significant at ($P \leq .05$), odd ratio: 1.090 and confidence interval of 0.955–1.244 at 95% confidence.

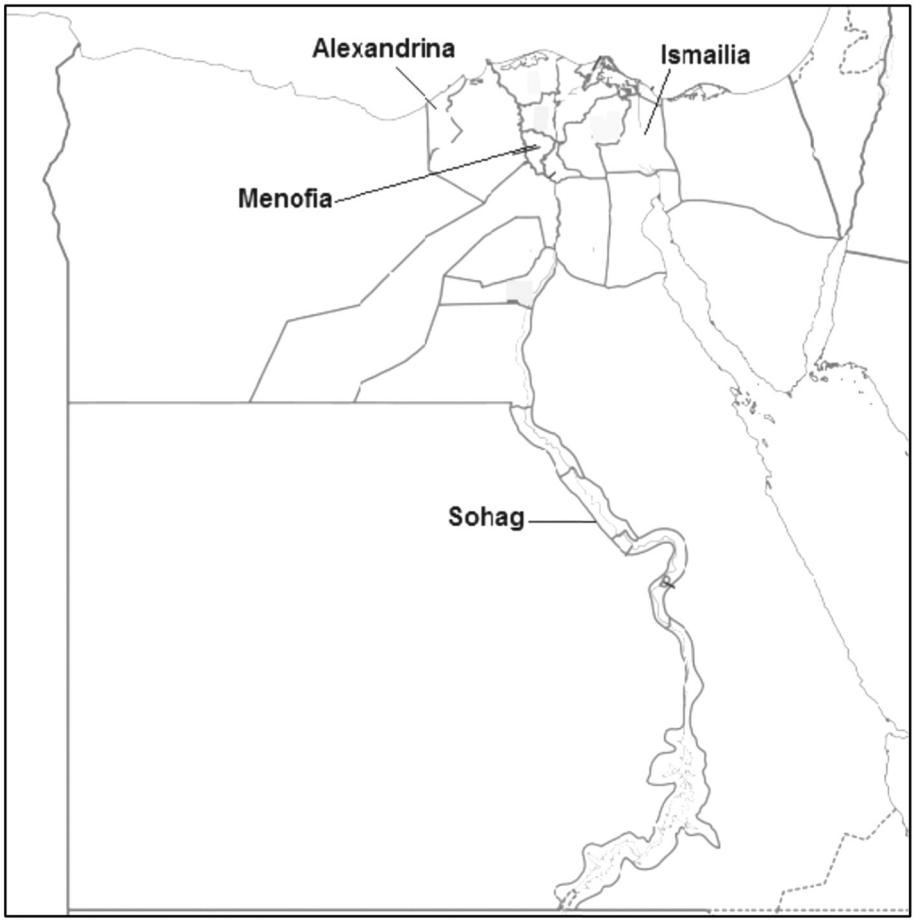

Fig. 1. Diagrammatic Map of Egypt showing the four studies Governorates.

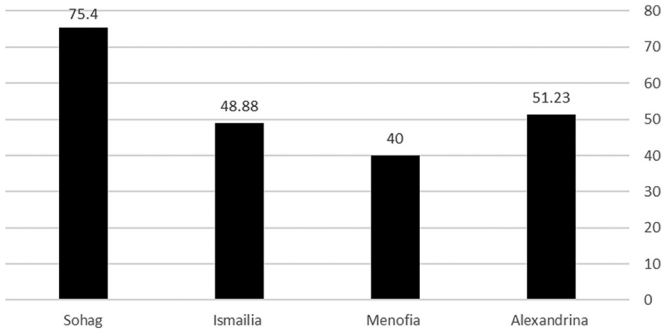

Chart 1. The infection rate of Toxocara canis among examined dogs in relation to locality.

With respect to the management practice for dogs, collected data from the questionnaire that answered by dog owners revealed effective management of allowed dogs either confined or not and leashed or not was considered an associated risk factor for possible infection with *Toxocara canis* in dogs at odd ratio: 1.432 and confidence interval of 1.065–1.690 at 95% confidence. Finally, there is typically a possible co-infection with several responsible parasites such as; *Taenia* spp. Egg 12.5% (37/296) *Dipylidium caninum* egg 26.01% (77/296) and *Giardia canis* cyst 11.82% (35/296). This factor of co-infection with other parasites was not a possible risk factor for toxocariasis infection with odd ratio: 0.9432 and confidence interval of 0.865–00.990 at ($P \leq .05$), (Table 1).

4. Discussion

Understanding the epidemiological pattern of parasitic zoonotic diseases is critical for minimization of the threat to humans. Among others, Dogs play an important role in maintaining the transmission cycle of various parasitic zoonoses. The impact of these diseases could be fatal as in case of *T. canis* which is naturally infecting the human being by accidental ingestion of the infective stage resulting in visceral and ocular larva migrans complex syndrome. In our present work, the overall prevalence of *T. canis* eggs was (53.04%). Our present results are different than several previous studies were carried out in in Egypt, such as that study was carried out where the reported prevalence was (5.38%) which is not in agreement with the present result, such as; Awadallah and Salem (2015). Also, previous lower overall prevalence was recorded by Khalil (1964) on toxocariasis in the Siwa oasis, Ahmed et al. (2014) in Alexandria, and by Awadallah and Salem (2015) in Sharkia, and Qaliubiya governorates. This difference of the previous studies than our present results may be attributed to the enviromental changes in climatic condition that allowed the maturation of fertilized *Toxocara canis* eggs in soil in Egypt. Nearly similar results to our present data have been reported worldwide such as that carried out by Fok et al. (2001) in Hungary where the overall prevalence was (53%). However, lower overall prevalence were also reported elsewhere worldwide such as the following overall prevalence Papini et al. (2012) in Italy was 3.5%, Claerebout et al. (2009) in Northern Belgium was 4.4%, Yamamoto et al. (2009) in Japan was 12.5%, Klimpel et al. (2010) from Brazil was 8.7%, and Blagburn (2001) recorded 14.54% in USA. This variation might be due to differences in management systems, health care and degree of environmental contamination with infective as stated by Blagburn (2001), As shown in our results, the age

Table 1
Prevalence of *Toxocara canis* among examined dogs in relation to different associated risk factors.

Risk factor	Group	No. Ex.	+ve.	(%)	O.R.	(C.I.) 95%	P. value	S.E.
Locality	Sohag	61	46	75.4	0.766	(0.633–0.926)	0.006	0.097
	Alexandria	162	83	51.23				
	Ismailia	45	22	48.88				
	Menofia	28	7	40				
Gender	Male	192	99	51.56	0.954	(0.603–1.508)	0.840	0.234
	Female	104	48	46.15				
Season	Summer	127	91	81.65	1.052	(0.823–1.344)	0.688**	0.125
	Autumn	72	36	50.00				
	Spring	38	12	31.37				
	winter	95	17	28.81				
Age	<8 w.	79	37	46.83	0.991	(0.807–1.128)	0.933	0.105
	8–24 weeks	24	13	54.16				
	24w- 2 years	148	77	52.02				
	>2 y.	45	18	40				
Other parasitic infection	*Taenia* spp. eggs	296	37	12.5	0.9432	0.865–00.990	0.982	0.039
	Dipylidium caninum		77	26.01				
	Giardia canis cyst		35	11.82				
Dog breed	Mixed breed	80	51	63.75	1.018	(0.863–1.201)	0.834*	0.084
	Griffon	33	20	60.60				
	Rottweiler	33	18	54.54				
	German shepherd	99	47	47.47				
	Pit bull	47	20	42.55				
Anthelmintic use	Regular	92	2	2.10	6.401	4.265–9.606	0.00**	0.207
	Irregular	105	81	77.14				
	No drugs	96	73	70.04				
Defecation site	Garden	113	62	54.86	1.090	0.955–1.244	0.203*	0.067
	Street	105	57	54.28				
	Sand box	78	36	46.15				
Managmental practice	Confined	95	55	57.89	1.342	1.065–1.690	0.012*	0.1180.067
	unconfined	80	47	58.57				
	leashed	89	43	48.31				
	unleashed	32	10	31.25				

O.R: Odd. Ratio, S.E: Standard Error, C.I.: confidence interval, Pvalue:significance level at 95%.
* Significant at 95% confidence ratio, at (P ≤ .05).
** Significant at 99% confidence ratio at (*P* ≤ .001).

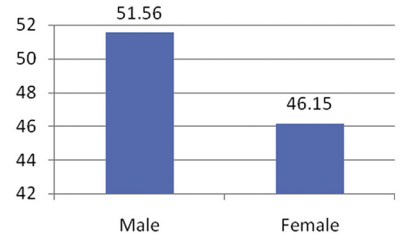

Chart 2. Infection rate of Toxocara canis among examined dogs in relation to sex.

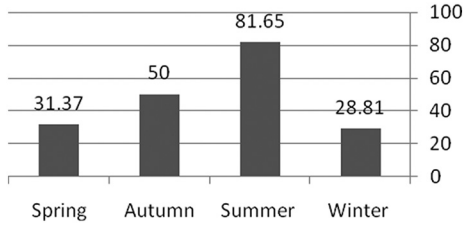

Chart 3. Infection rate of *Toxocara canis* in relation to season.

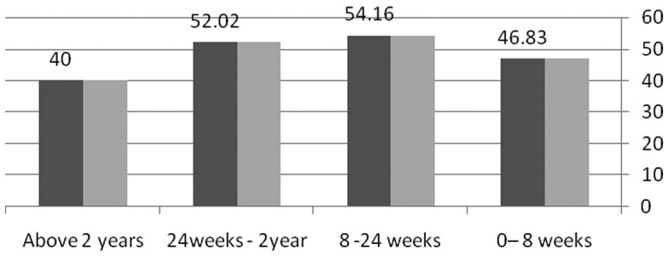

Chart 4. Infection rate of *Toxocara canis* among examined dogs in relation to Age.

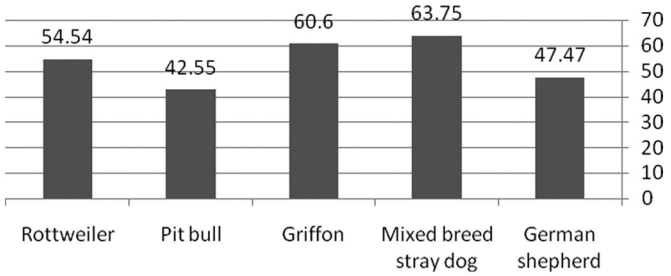

Chart 5. Infection rate of *Toxocara canis* among examined dogs in relation to animal breed.

factor was negatively correlated to potential infection that means that younger dogs are at more significant risk of infection that might be attributed to their less developed immune system. Additionally, the expected high prevalence of *T. canis* recorded in the dogs with age 0–6 months is in the same line with the transmission pattern of the parasite, which is mainly by transplacental and transmammary possible

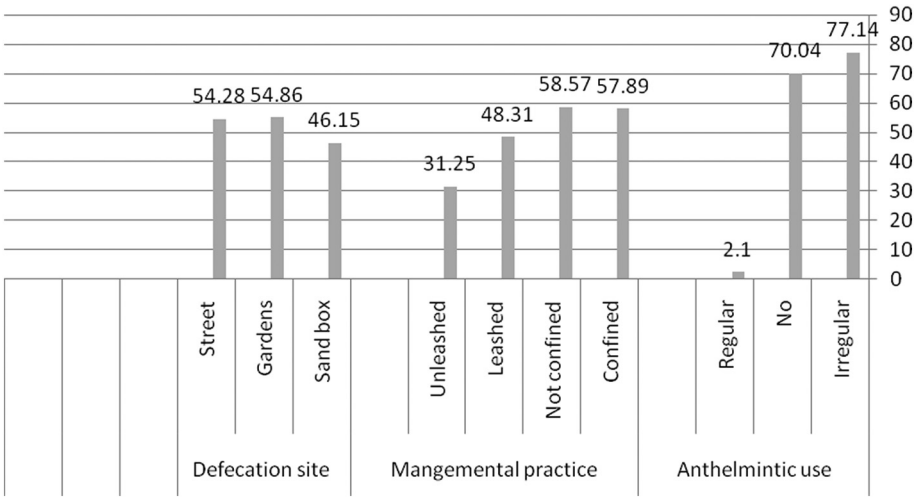

Chart 6. Infection rate of *Toxocara canis* among examined dogs in relation to defecation site, managemental practice, and anthelmintic use.

routes in younger ages. The acquired age-dependent immunity by adult dogs typically decreases the proper establishment of the infection. Also, other several factors could influence this topic such as the fecundity of the parasite [Pereckiene et al. (2007)], and as consequence of frequent exposure acquired [Oliveira-Sequeira et al. (2002), Fontanarrosa et al. (2006), Katagiri and Oliveira-Sequeira (2008)]. The variation in overall prevalence between observed males and allowed females are almost alike as reported by Rubel et al. (2003), and Ramirez-Barrios et al. (2004). However, no significant difference was observed between determined sexes of the studied group but it can be properly explained by the immunosuppressive testosterone activity and the wandering behavior displayed by most male as described by Curia et al. (2017).

To our knowledge, the successful development of intestinal nematode eggs depends on favorable climate conditions that might explain the increased transmission rate observed in our local survey during summer season. Likewise, it might suggest that this type of parasite has the ideal conditions for development and hatch in summer and autumn, seasons when high temperatures (25–30 °C), humidity near to 80% and an intermediate rain pattern (333.5 l/m^2) in screened Egyptian cities prevail. In the present survey, mixed breed dogs which are considered the stray dogs in Egypt were significantly associated with the apparent higher prevalence of *T. canis* and were typically retained as a significant risk factor. High prevalence of *T. canis* possible infection in this breed might indicate that stray dogs roam freely without proper administration of suitable anthelmintic drugs. Additionally; they more susceptible to infection through the ingestion of the paratenic host as food sources because of their scavenging habits. In the same line, several studies reported a high prevalence among stray or uncared dogs than kennel dogs [Minnaar et al. (2002), Martinez-Moreno et al. (2007), and Sowemimo (2009)]. Also, the different breeds of considered dogs carefully examined were retrieved to harbor diverse levels of active *Toxocara* infection. Our reliable data are comparable with the direct observations prominently displayed by Kutdang et al. (2010), where the infection rate typically varies from 52.3 % in cross-breeds and 91.0 % in Alsatian breeds. Exotic breeds were recognized to be slightly less infected with *T. canis* than the local mixed breeds. This may be due to several factors such as better anthelmintic treatment, proper nutrition, good management, and adequate sanitation.

Regardless this variation and given our present results, this important finding pay our attention towards the serious public health concern attributed to stray dogs in Egypt.

Our questionnaire data on defecation sites precisely revealed that a significant percent of the tested dogs defecate outside, unleashed (free) that not confined to a limited space were naturally infected with *T. canis*. The potential implication of this point might be that since local dogs are typically left to roam aimlessly the streets unhindered, and therefore higher possibility of contaminating the local environment with *T. canis* fertile eggs which are voided with feces. Children usually play in grounds are likely to be contaminated with fertile eggs and exposed to accidental ingestion of the eggs through their social habits which is considered a strongly associated risk factor for the possible infection with *T. canis*. The present study also showed a significant association between irregular anthelmintic treatments and infection. This might confirm the hypothesis stated that the shedding of fertile *Toxocara* eggs instantly appears to be prevented when dogs are treated regularly, 12 appropriate times per a year as stated by Beugnet et al. (2014).

In our present work, However, there were several other parasitic infections in examined dogs such as *Taenia* spp. eggs, *Dipylidium caninum* egg pocket and cyst of *Giardia canis*, it seems to be there is no any significant association between the infection rate with toxocariasis infection and the infection by these parasities a. Given the fact that several factors might influence this variation between the data of risk fatcors in the previous reports either at national and international level and our present work such as unconventional designs, dog populations and definitions of outcome and potential exposure.

5. In conclusion

Taken together, our present data concluded the following:

1- This is properly the first epidemiological study on *Toxocara canis* local infection including northern, middle delta and southern region of Egypt.
2- The most important associated risk factor for possible infection with *Toxocara canis* in the study were seasonal dynamics, dog breed, the irregular anthelmintic (Drontal), defecation site, and bad management practices.
3- Given the fact that *Toxocara canis* represents a high public health risk, and therefore, the high prevalence of this zoonosis constitutes a possible threat to the local people living properly in the study areas in selected provinces.
4- The dogs owners and local authorities must merely ensure the essential provision of dog's veterinary clinics and academic laboratories besides enforcing the periodical follow up to diminish the risk of the trasnsmiiton of this zoonotic parasite.

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Conflict of interest statement

The authors declare that they have no conflict of interests.

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