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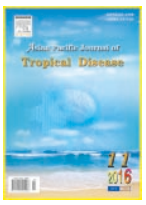

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Soil transmitted helminths in animals – how is it possible for human transmission?

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ABSTRACT

Objective: To determine the current prevalence of soil transmitted helminths (STH) infections among cats and dogs in an animal shelter.

Methods: A total of 442 animal's faecal samples were collected from the selected animal shelter located in Kuala Lumpur, Malaysia. The samples were screened by direct smear and further confirmed by formalin-ether sedimentation methods.

Results: The overall prevalence of STH in animals was 48.4%. Among these, 51.5% and 45.8% were found in dogs and cats respectively. Among feline, hookworm was found to be the most predominant (41.7%), followed by *Toxocara cati* (4.6%). Whereas, hookworm was found to be the most predominant in canine (47%), followed by *Toxocara canis* (15.8%) and *Trichuris vulpis* (5.9%).

Conclusions: A high prevalence of STH infections was found among animals living in this local shelter. Hence, appropriate preventive measures should be taken to eradicate these infections.

1. Introduction

Zoonosis or zoonotic disease is an infection that transmits naturally from vertebrate animals to humans. Zoonotic diseases can be caused by viruses, bacteria, fungi, as well as parasites. Among these, soil transmitted helminth (STH) is a group of parasitic nematode that infect both humans and animals through the ingestion of infective eggs or through contacting with its larvae. It has also been suggested that domestic cats and dogs play a crucial role in parasitic transmissions to humans and other animals through an environment that has been contaminated with the infected animal's faeces[1]. There are three main species of STHs, which include hookworms, *Toxocara* spp. and *Trichuris* spp., that are known to be the cause of major health problems among animals.

Hookworm is a parasite that is known to inhabit the small intestines of humans and animals, in which the cats and dogs hookworm species, such as *Ancylostoma ceylanicum*, *Ancylostoma braziliense* and *Ancylostoma caninum* are potential agents to cause zoonotic disease in humans[2,3]. The eggs of these parasites that are shed in the faeces can eventually contaminate the ground where the animal defecates. People become infected when the hookworm larvae penetrate unprotected skin, especially when walking barefoot or sitting on contaminated soil or sand. This can result in a disease called cutaneous larva migrans, where the larvae migrate through the skin and cause inflammation[4]. The symptoms caused by these zoonotic hookworms include eosinophilic enteritis, abdominal pain, diarrhoea, and less frequent symptoms such as localized myositis and erythema multiforme, and ophthalmological manifestations may occur[5-7]. Among the variant species, *Ancylostoma ceylanicum* is the only species of animal hookworm known to produce patent infections in humans and it is the second most common hookworm species infecting humans in Asian countries, such as Cambodia, Thailand, Laos, Malaysia, China and the Philippines[6-12]. *Ancylostoma caninum*, which is the canine hookworm, remains

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The ethical consideration (reference no. MEC1024.6) was obtained and approved by the Ethics Committee of the University Malaya Medical Centre, University of Malaya, Kuala Lumpur, Malaysia, prior to samples collection. Permission was also obtained from the respective authority of the animal shelter.

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the leading cause of human eosinophilic enteritis[6,13]. An outbreak of 150 cases was reported between 1988 and 1992 in Australia[14]. Moreover, several cases have also been reported in the USA, Mexico, India, Iran and the West Indies[15-20].

Toxocariasis results from the zoonotic transmission of roundworms, *Toxocara canis* (*T. canis*) and *Toxocara cati* (*T. cati*) from dogs and cats, respectively. Infection occurs when humans accidentally ingest the embryonated eggs that shed in dog and cat faeces via hand-to-mouth contact. Children are particularly prone to infection because they are exposed to the eggs in sandboxes and on playgrounds contaminated with dog and cat faeces[21,22]. After ingestion of the eggs, the released larvae penetrate the intestine and migrate through the liver, lungs and central nervous system, leading to two major clinical syndromes known as the visceral larva migrans and ocular larva migrans[23]. Visceral larva migrans occurs most commonly in young children and results in hepatitis and pneumonitis, as the larvae migrate through the liver and lungs, respectively. The full clinical presentation of toxocariasis includes hepatomegaly and pulmonary infiltrates or nodules accompanied by cough, wheezing, eosinophilia, lymphadenopathy and fever. Larval entry into the central nervous system can also result in meningoencephalitis and cerebritis and result in seizures[24-26]. Ocular larva migrans occurs more frequently in older children and adolescents and may result from the migration of even a single larva in the eye[27]. The manifestation of the infection is usually unilateral[27,28]. However, the resulting inflammation presents clinically as either a granuloma or a granulomatous larval track in the retina or as a condition of the vitreous body resembles endophthalmitis[29,30]. In serious cases, it may cause permanent vision lost in the patient[29].

Zoonotic trichuriasis is an infection caused by whipworm[31]. A few clinical cases that were triggered by *Trichuris vulpis* (*T. vulpis*) originating from dogs were reported in Thailand, the USA and Mexico[32-35]. In comparison to *T. vulpis*, *Trichuris serrata* and *Trichuris campanula* are the two species of whipworms that can infect cats. There was a low prevalence of parasites in cats reported in previous studies. As a result, whipworm infection in cats is not a primary differential diagnosis for cats with diarrhoea[36].

To date, most studies have focused more on STH infections among humans and the aborigine population. However, data on the prevalence of STH infections among animals living in local shelters are still lacking. In addition, most of the literatures have proposed the prevalence of STH infection among animals in Western countries. However, this information remains scanty in Malaysia. Hence, this study was conducted to determine the prevalence of STH infection in animals living in an urban local shelter. The establishment of such data may shed some light on the topic for public health authorities as they can rectify the effectiveness of current control programs and for the planning of control strategies to reduce the prevalence of STH infections in animals.

2. Materials and methods

2.1. Ethics statement

The ethical consideration (reference No. MEC1024.6) was obtained and approved by the Ethics Committee of the University Malaya Medical Centre, University of Malaya, Kuala Lumpur, Malaysia, prior to samples collection. Permission was also obtained from the respective authority of the animal shelter.

2.2. Study design

The selected local animal shelter (Figure 1) is a non-government organization that provides basic necessities (foods, vaccinations, medical related treatments and adoptions) for more than 500 animals to facilitate their future adoption. The animals were either

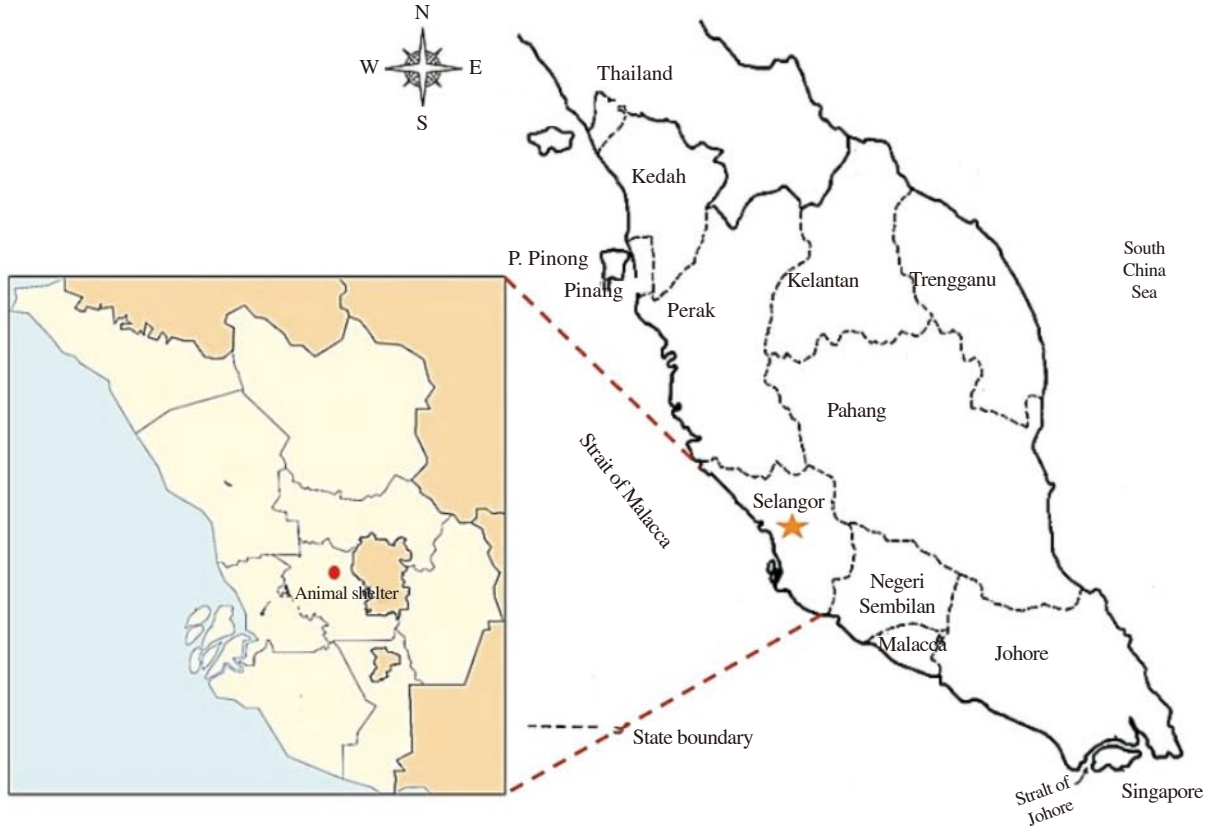

Figure 1. The location of selected animal shelter in this study.

surrendered pets (cats and dogs) from their owners and/or also temporarily placed as stray cats and dogs.

2.3. Sample collection and laboratory analysis

To expedite the process of collection, wide-mouthed and screw-cap containers were distributed to the person in charge of the animal shelter, and proper instructions for stool collection were explained clearly. The faecal samples collected were first examined for the presence of STH using the direct smear method. Then, each sample was screened via a formalin-ether sedimentation and McMaster counting techniques to increase the detection rate. Extra information about the animals, such as age and gender, was also included. This information was obtained from the manager of the shelter.

3. Results

3.1. Demographic profile

A total of 442 fresh faecal samples, consisting of 54.3% (240/442) cats and 45.7% (202/442) dogs with variant breed and age groups, ranging from 1 to 5 years old, were collected and processed.

3.2. Prevalence of STH infections in animals

The overall prevalence of STH infections in animals were 48.4% (214/442), in which 51.5% (104/202) and 45.8% (110/240) were found in dogs and cats respectively. In cats, the highest prevalence of STH infection was found to be hookworm (41.7%; 100/240) followed by *T. cati* (4.6%; 11/240). Meanwhile, canine faecal samples showed the highest rates of STH infections with hookworm (47.0%; 95/202) followed by *T. canis* (15.8%; 32/202), and lastly *T. vulpis* (5.9%; 12/202).

The complexity of STH infections among animals was further divided into three categories, which are single, double and triple infections. The prevalence of hookworms among cats was found to be 38.8% (93/240) followed by *T. cati* (1.7%; 4/240). On the other hand, hookworm-burden among dogs was found to be 35.1% (71/202) followed by *T. canis* (5.4%; 11/202) and *T. vulpis* (1.5%; 3/202). For double infection, the prevalence of feline STHs was only 2.9% (7/240) infected with hookworm and *T. cati*, while the prevalence of canine STHs was 7.9% (16/202) infected with hookworm and *T. canis* followed by hookworm and *T. vulpis* (2.0%; 4/202) and lastly, *T. canis* and *T. vulpis* (0.5%; 1/202). However, only 2.0% (4/202) of canine samples were found positive for triple infections (hookworm, *T. canis* and *T. vulpis*).

4. Discussion

In the present study, the overall prevalence of animal STHs was 48.4% and the highest prevalence was found with hookworm infection followed by *Toxocara* spp. (roundworm) and *Trichuris* spp. in both cats and dogs. This finding was similar to a previous study that reported the highest percentage of hookworm (24.5%) followed by roundworm (11.4%) infection but no whipworm infection was detected in dogs under veterinary care in Venezuela in the report[37]. On the other hand, a report from Cambodia also demonstrates the high prevalence of hookworms in dogs[38]. However, our result was contrary to a previous study that showed the highest prevalence of hookworm infections in both dogs and cats, which was followed by whipworm and roundworm infections[39]. Moreover, a similar research has been conducted in Peninsular Malaysia recently. The final outcome of the study is interesting, as no hookworms were detected and the most commonly found STH was *Toxocara* spp. followed by *Trichuris* spp.[40]. The possible reasons that contributed to the difference in our finding as compared to other studies were due to the differences in soil, climates and altitude of the locations.

Based on the type of STH infections, single STH infection was most predominantly detected. Whereas, multiple infections were the least commonly found in this shelter. In feline, the prevalence of single infection was higher (40.4%) compared to double infection (2.9%). Single STH infection was also shown as a higher prevalence (42.1%) than mixed infections (12.4%) found in canine. This finding was surprisingly supported by previous studies[37,41,42]. In single STH infection, our findings showed that hookworm infection was the highest single STH infections found in the animal population. Interestingly, our result has also shown this to be a higher prevalence compared to an earlier study conducted among animals under veterinary care and in a veterinary teaching hospital[37,42]. One possible reason for this is the animals' living environment. Stray animals have a free-roaming environment, causing it to have a higher chance to come in contact with contaminated soil, and hence, become infected with various parasites[43]. Veterinary-based shelters, on the other hand, have cleaner and more sterile environments as compared to the animal shelter. Apart from that, extra care is usually given in the veterinary hospital, leading to a lower prevalence of STH infection among animals.

Our finding conflicts with a previous study done in Alberta, which showed that *Toxocara* spp. was the highest prevalent found among intestinal parasites in a broad demographic spectrum of cats and dogs[44]. Both *T. canis* and *T. cati* in dogs and cats can cause consequential effects to humans. *T. canis* more frequently occurs in humans. However, the proneness of *T. cati* should not be underestimated[45]. In view of *Trichuris* spp., our finding showed the prevalence of this STH infection in both cats and dogs was lower than the previous study[46]. It is noteworthy to highlight the importance of molecular characterization of *Trichuris* spp. Definitive diagnosis of trichuriasis relies on identification of characteristic *Trichuris* eggs. The egg of *Trichuris trichiura* found in stool samples is measured to be 50–54 μm in length and 22–23 μm in width. *Trichuris* eggs that have larger size (70–80 μm in length and 30–42 μm in width), with prominent but relatively small bipolar mucoid plugs commonly

belong to *T. vulpis* or dog whipworm[32]. Although *T. vulpis* eggs are usually larger than *Trichuris trichiura* eggs, morphometric study has revealed an overlapping length between eggs of these nematodes. This could mislead to a diagnosis of *Trichuris* spp. based on egg dimension. Therefore, it is recommended that future studies on molecular characterization of *Trichuris* spp. could be done to enhance the ability to identify the parasite species in faecal samples but from the perspective of being different host specific. Overall, control measures are necessary to eliminate the parasite load and zoonotic transmission, particularly in close proximity with care-givers and workers in their respective shelters.

Based on this preliminary study, a high prevalence of STH infections was found among animals living in this local shelter. Thus, preventive measures need to be taken to reduce parasites in animals as well as prevent zoonotic transmission to humans. Proper management is recommended to sustain hygienic conditions in the animal shelter such as good food and clean water, sanitation, deworming, vaccination and regular check-ups for these animals. These similar control strategies should also be implemented among other unwanted animals that are temporarily being sheltered at the facility since these animals can cause zoonotic transmission to humans. Stray animal protection programs such as Trap, Neuter, Release/Return and Manage can be implemented including sheltering, sterilization and tagging, veterinary care, vaccination and parasite control to reduce the animal population in general and human zoonotic diseases in particular. Public awareness on issues related to protection of stray animals can also be highlighted by educating and encouraging the adoption of strays rather than buying from animal breeders.

Conflict of interest statement

We declare that we have no conflict of interest.

Acknowledgments

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