

# A Systematic Review on the Prevalence of Soil-Transmitted Helminth (STH) Infection from Cats and Dogs in Asia

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## ABSTRACT

**Aim/Background:** Parasitic infections from both cats and dogs are considered a recurring problem in several developing countries. This review intends to provide the current cases, through published articles in various scholarly databases, the current prevalence of STH infection in dogs and cats. **Materials and Methods:** Isolation and epidemiological studies that focus on isolation of dog and cat intestinal parasites between 2010 and 2020 in Asia were searched systematically in PubMed, Research Gate, Google Scholar, and Science Direct databases, 106 articles are considered in this study, coming from 21 Asian countries. **Results:** A total of 106 articles are considered in this study coming from 21 Asian countries and initial analysis of qualified articles revealed 5, 028 documented isolated STH in dogs and cats with *Ancylostoma caninum* (1291; 25.7%) having the highest prevalence infecting dogs followed by *Toxocara canis* (999; 19.9%), while *A. ceylenicum* (12; 0.2%) and Ascarid worms (32; 0.6%) had low report isolations. **Conclusion:** Both hookworm and *Toxocara* infection in humans are considered public health concerns and their impact does not only include individual health but also the socio-economic impacts of the worm burden are undeniable. Until the time that effective prevention and therapeutic intervention has been implemented, surveillance studies for this neglected parasitic infection should be focused by both researchers and clinicians.

**Keywords:** *Ancylostoma caninum*, *Ancylostoma duodenale*, Asia, hookworms, *Toxocara*.

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## INTRODUCTION

The World Health Organization (WHO) considered zoonotic infections as one of the main public health concerns affecting millions of people around the world.<sup>[1]</sup> Among those considered as biological reservoirs for zoonotic infections, dogs are primarily the most common sources of animal-to-human transmission.<sup>[2]</sup> Some of the potential diseases acquired from close affinity with dogs are: bacterial infections such as but are not limited to Salmonellosis, Campylobacteriosis, and Brucellosis; viral diseases Rabies and Novovirus.<sup>[3]</sup> and

parasitic infections caused by protozoans, arthropods, and helminths.<sup>[2]</sup> Helminthic infection acquired from stray and domesticated dogs has been proven to be the most common zoonotic infection where dogs play a crucial role in the transmission process.<sup>[4]</sup> *Toxocara canis* is an ascarid roundworm that commonly infects dogs.<sup>[5]</sup> it is considered an accidental parasite of humans, it accounts for a much higher rate of infection especially in young children in developing countries.<sup>[6]</sup> Moreover, toxocariasis has been declared by the Center for Disease Control (CDC) as one of the neglected parasitic infections in humans due to the steady rise of morbidity in developing countries. *Ancylostoma caninum* is another type of STH infection in dogs that has been linked with human infections, especially in developing countries with poor access to clean water, inadequate sanitation, and poor hygiene.<sup>[7]</sup> Although dogs serve as the definitive hosts, humans become

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accidental hosts upon contact with contaminated soil where hookworm larvae enter the body through the skin. This mechanism triggers a cascade of events that leads to the activation of immune responses that lead to a skin condition known as creeping eruption.<sup>[8]</sup> This helminth is considered as the most common hookworm-infecting dog.<sup>[9]</sup>

Dogs and cat zoonotic hookworms are distributed worldwide, predominantly in places with warmer climates.<sup>[10]</sup> Tropical and subtropical are the regions where these parasites can survive and occasionally in places with cold climates. Hookworm infection is most likely caused by walking barefoot in a soil-contaminated dog or cat feces positive for hookworm ova. Infection is mostly occurring in the population who belong to a low socioeconomic class where dogs and cats are often seen as stray animals transmitting the eggs or larvae of hookworms to sand and soil. In one study conducted in Brazil for the prevalence of STH infection, 98.1% (622/634) turned out positive for *Necator americanus* while 1.9% (12/634) are positive for *Ancylostoma caninum*.<sup>[11]</sup> The global prevalence of *A. caninum* is not known but there are certain countries in the globe that had done similar studies. In remote parts of western Malaysia, 634 humans and 105 domestic canine and feline faecal samples were tested and the overall prevalence of hookworms was 9.1% (95% CI=7.0-11.7%) for humans and 61.9% (95% CI=51.2-71.2%) for canine and felines (Ngui *et al.*, 2011). In a survey done in Brazil, the prevalence of Cutaneous Larva Migrants during the rainy season is 0.7% in adults aged 20 and above; and 14.9% in children less than 5.<sup>[12]</sup> In a study done in the Philippines, 52.8% (n=228/432) were positive for any hookworm infection, 34.5% (n=149/432) infected with *N. americanus*, and 29.6% (n=128/432) individuals were infected for *Ancylostoma* spp.<sup>[13]</sup>

The high prevalence of dog and cat-related STH cases in the world provides enough warrant to conduct surveillance studies to provide a bigger picture of the extent of infection of this public health problem. This review intends to provide the current cases, through published articles in various scholarly databases, of the current prevalence of STH infection in dogs and cats.

## MATERIALS AND METHODS

### Literature Search Strategy

Isolation and epidemiological studies that focus on the isolation of dog and cat intestinal parasites between 2010 and 2020 in Asia were searched systematically in PubMed, Research Gate, Google Scholar, and Science

Direct databases to provide an updated prevalence on the current status of the prevalence of intestinal helminthes in cats and dogs in Asia. The search term used to obtain the relevant studies were: “hookworm”, “*Necator americanus*”, “*Ancylostoma duodenale*”, “*Ancylostoma caninum*”, “*Ancylostoma braziliense*”, “*Toxocara*”, “*Toxocara canis*”, and “*Toxocara cati*”. To maximize the number of included studies and to prevent any missing studies during the searches of the main database, country specific searches were made, and the reference list of accepted articles was searched for any additional articles to be included.

### Eligibility criteria

The inclusion criterion for this study involves reported cases and isolation of intestinal helminthes in cats and dogs. The exclusion criteria, however, were: (1) Reviews and mini-reviews, (2) studies of isolation of intestinal helminthes in humans, (3) studies that focus on method evaluation, (4) Intervention studies, and (5) articles not written in English.

### Data Extraction

Data such as country location, year of study, isolated organism, type of sample used, and percent of isolated organisms, methods used for identification, title, and author were extracted from the included articles for the purpose of standardization.

## RESULTS

Two hundred eighty-three (283) articles are screened using the keywords used in this study. Eleven (11) articles were removed and considered as duplicate titles. A further 183 articles were removed due to the following reasons: 8 studies were conducted before 2010, 46 articles are non-prevalence studies of intestinal helminth infection of cats and dogs, 25 articles are review papers, 2 meta-analysis papers, 1 paper has ambiguous data, 33 studies are intervention studies, 58 articles are not from the Asian region, 9 articles are isolation studies of other parasite of cats and dogs, and 1 article is not written in English (Figure 1). After the exclusion of non-qualified articles, 106 articles are considered in this study coming from 21 Asian countries (Table 1). Initial analysis of qualified articles revealed 5, 028 documented isolated STH in dogs and cats with *Ancylostoma caninum* (1291; 25.7%) having the highest prevalence infecting dogs followed by *Toxocara canis* (999; 19.9%), while *A. ceylanicum* (12; 0.2%) and *Ascarid* worms (32; 0.6%) had low report isolations (Figure 2). The distribution of isolated STH per country can be seen in Figure 3.

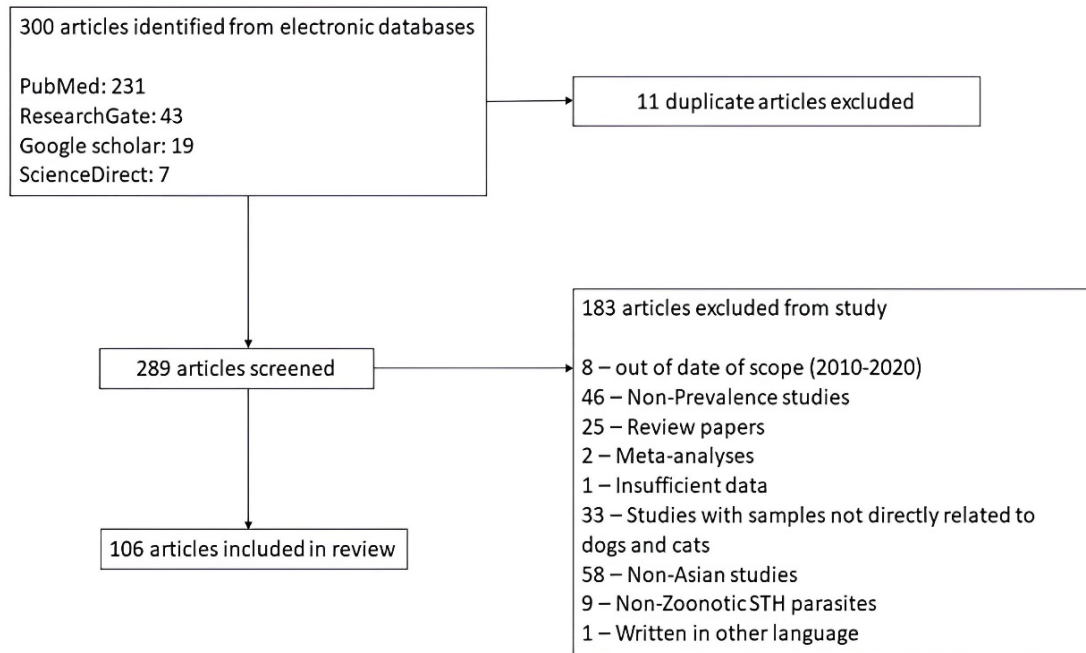


Figure 1: Flow diagram of study selection process for including articles in the study.

## DISCUSSION

Dogs and cats are considered as the closest domesticated animals in terms of contact with humans, with dogs being the first domesticated.<sup>[120]</sup> For this reason, parasitic infections from both cats and dogs are considered a recurring problem in several developing countries. Challenges in terms of prevention and control are some of the problems encountered in terms of zoonotic parasitic infections passed on to humans by these animals. In this study, we have provided baseline data on the current prevalence and effects of infection of parasitic organisms passed on from cats and dogs to humans.

### *Ancylostoma* spp. as an emerging pathogen in Asia

*A. caninum* is considered as the most common hookworm infecting dogs and comprises about 19% of total *Ancylostoma* eggs identified in the United States.<sup>[121]</sup> Its transmission may vary from one host to another which involves transmammary, percutaneous or accidental ingestion of larvae. Whichever the case of transmission, larvae within hosts may not develop as adults but rather migrate to somatic tissues.<sup>[122]</sup> In humans, the effects of infection are known as Cutaneous Larva Migrans (CLM) which is described as an irritating skin condition due to the penetration of hookworm larvae from soil contaminated with the latter as well as eosinophilic enteritis, and diffuse unilateral subacute

neuroretinitis.<sup>[123]</sup> The CDC confirms that the current prevalence and morbidity of people suffering from CLM and other hookworm infections from dogs and cats alike are unknown.<sup>[118]</sup> With this said *Ancylostomiasis* in humans can be considered as a neglected parasitic infection of our time.<sup>[124]</sup> In this study, it is important to note that countries affected with *Ancylostoma* spp. infections the most are India, Iran, and Malaysia. Climate and season may perhaps explain the reason for this, largely, Several Asian countries have a tropical climate setting, and this natural climate setting is favorable to hookworms in terms of their further development in the soil to become potentially infective to their mammalian host. To further argue, studies have shown that behavioral and environmental factors, especially in rural populations, are important causes of CLM infection.<sup>[125]</sup> Although statistics from this study have shown this is true, it should be noted that the numbers from other reports would say otherwise, for this reason, we should consider the possibility of under reporting of cases may occur since current laboratory protocols would only provide a general manner of hookworm reporting, rather than specie specificity. Further, speciation of identified hookworm infection can only be attained once tests are subjected to a much specific assay such as molecular methods, which, unfortunately, is not a routine analysis done in stool examination. Still further, CLM is mainly an infection prevalent in rural settings.<sup>[125]</sup> until surveillance-specific studies on CLM

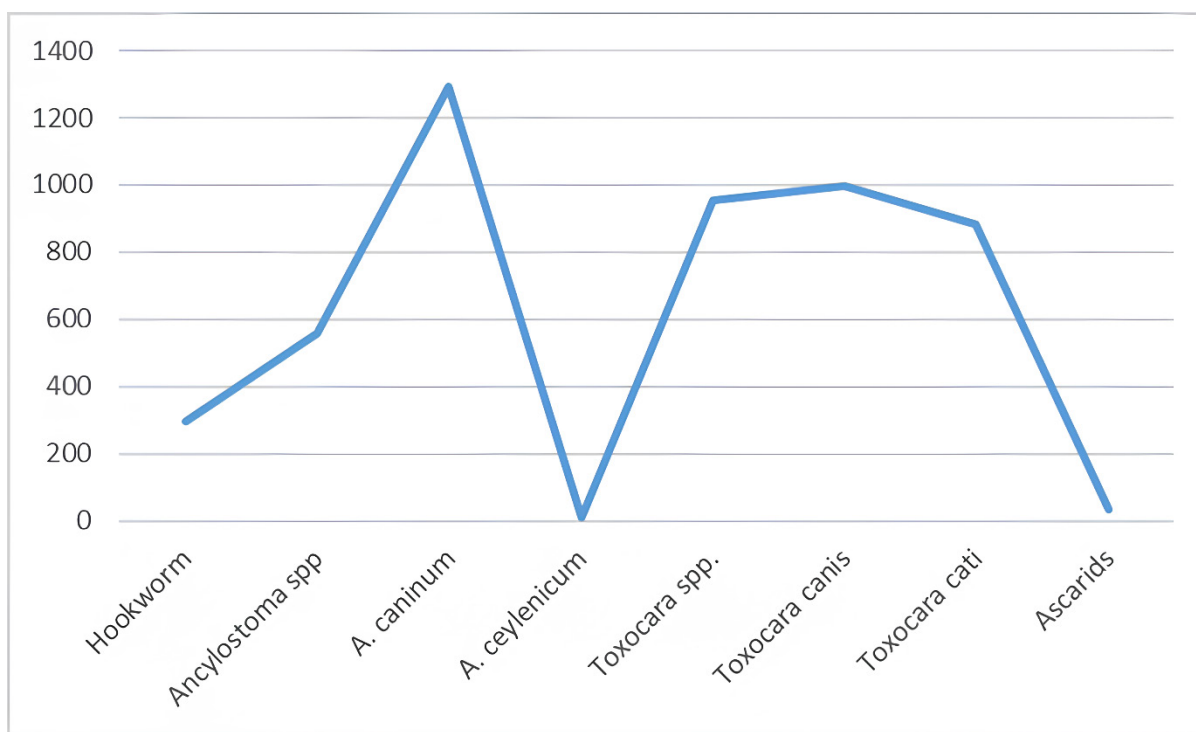
**Table 1: List of accepted articles in the study with the corresponding count per country.**

Country	Count	References
Bangladesh	3	[14-16]
Cambodia	3	[17-19]
China	12	[20-31]
India	12	[32-43]
Indonesia	2	[44,45]
Iran	27	[46-72]
Iraq	5	[73-77]
Japan	7	[78-84]
Korea	1	[85]
Laos	2	[86,87]
Malaysia	8	[88-95]
Nepal	2	[96,97]
Pakistan	2	[98,99]
Palestine	1	[100]
Philippines	2	[101,102]
Russia	2	[103,104]
Sri Lanka	2	[105,106]
Thailand	6	[107-112]
Turkey	4	[113-116]
Uzbekistan	1	[117]
Vietnam	2	[118,119]

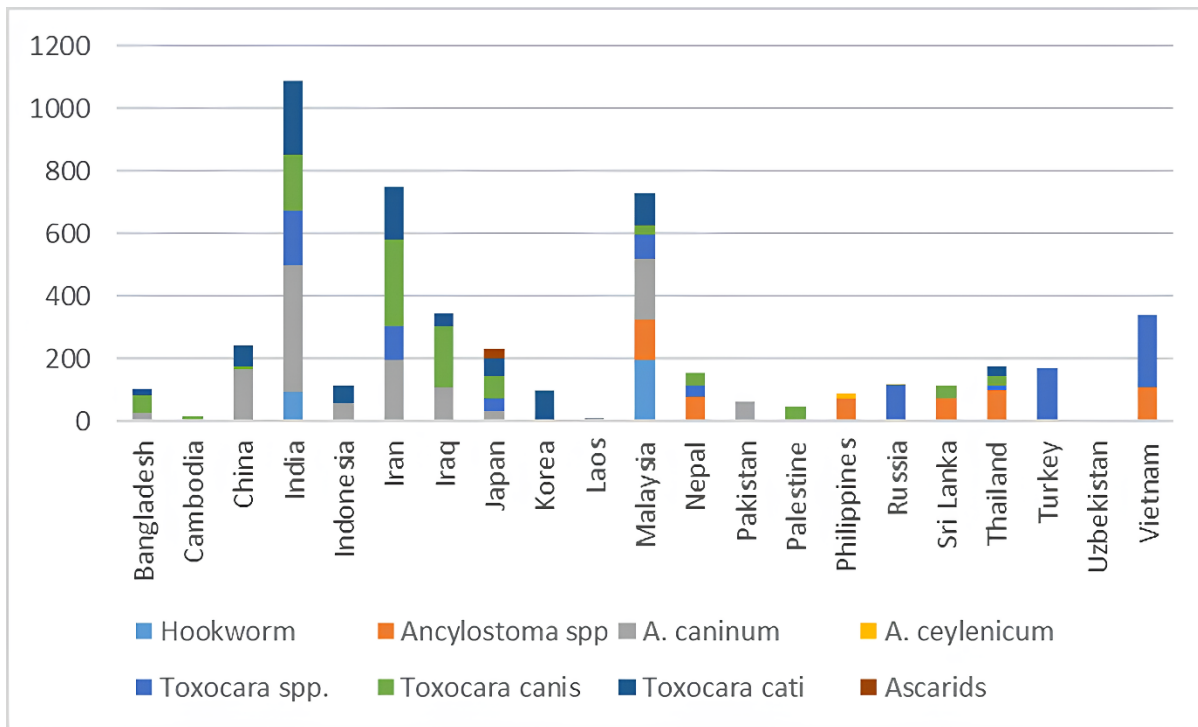
are done, then only by that time that the veracity of the true number of people with CLM can be known. In the meantime, the current data shows that *ancylostoma-related* CLM in humans are distributed across Asian countries and needs to be taken into consideration, especially in dealing with public health safety and awareness.

### Toxocariasis-a neglected parasitic infection in Asia

Like *Ancylostoma* spp. infection, *Toxocara* spp. infection shares the same notoriety in terms of being widespread when it comes to morbidity, but this time most often seen in pediatric and poor communities around the world and causes.<sup>[126]</sup> *Toxocara* spp. infection causes Visceral Larva Migrans (VLM) in humans. Mechanism of infection as well as mode of transmission greatly differs from CLM in the sense that VLM is initiated by the ingestion of embryonated eggs and the larvae hatching in the intestine then penetrating the mucosa and reaching the circulation where it is taken to different organs of the body.<sup>[127-129]</sup> Because of the migration capacity of *Toxocara* spp., it has been notable to induce extra-intestinal pathology and thus cause serious health problems, especially to the immunocompromised.<sup>[130]</sup> In this study, data shows that like *Ancylostoma* spp., the high prevalence of *Toxocara* infection is evident among Asian countries.



**Figure 2: Isolation count report of STH in accepted articles in the study showing *A. caninum* with the most common isolated nematode in dogs.**



**Figure 3: Distribution of intestinal STH in cats and dogs per country showing India, Iran, Malaysia with the highest reported case.**

Like hookworm infection, VLM is commonly observed in temperate countries.<sup>[131]</sup> Also, the prevalence of the infection can directly be associated with the current hygienic practices as well as dog and cat management in the region. This is true, especially when the shedding of embryonated ova is done by dogs and cats which are in close contact with humans. However, in some parts of the world, particularly developed countries such as the United States, the matter of Toxocariasis infection in humans has been steadily declining as seen in the last decade.<sup>[132]</sup> Collectively, this may not be true for many developing countries that have been struggling with both known and unknown cases of VLM within their territory.<sup>[128]</sup> Moreover, the continued increase of feral and stray populations of both dogs and cats in the region has contributed greatly to the increasing number of people infected with *Toxocara* spp.<sup>[133]</sup> These reasons provide enough warrant to conduct surveillance studies to determine the exact number of populations infected with VLM as well as research directed to the implementation of protocols for elimination and prevention of infective stages in the environment.

## CONCLUSION

Both hookworm and *Toxocara* infection in humans are considered public health concerns and their impact does not only include individual health but also the

socio-economic impacts of the worm burden are undeniable. Until the time that effective prevention and therapeutic intervention has been implemented, surveillance studies for this neglected parasitic infection should be focused by both researchers and clinicians. Finally, further enhancement of diagnostic skills in identifying potentially infected individuals are the key to a successful diagnosis which will consequently lead to proper medical intervention.

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## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

## FUNDING

Not Applicable.

## ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not Applicable.



## PATIENT CONSENT

Not Applicable.

## ABBREVIATIONS

**STH:** Soil-transmitted helminth; **CLM:** Cutaneous larva migrans; **VLM:** Visceral larva migrans.

## SUMMARY

WHO considered zoonotic infections as one of the main public health concerns affecting millions of people around the world. Isolation and epidemiological studies that focus on the isolation of dog and cat intestinal parasites between 2010 to 2020 in Asia were searched systematically to provide an updated prevalence on the current status of the prevalence of intestinal helminths in cats and dogs in Asia, and the results revealed 5, 028 documented isolated STH in dogs and cats, with *Ancylostoma caninum* (1291; 25.7%) having the highest prevalence infecting dogs followed by *Toxocara canis* (999; 19.9%), while *A. ceylanicum* (12; 0.2%) and Ascarid worms (32; 0.6%) had low reported isolations. Both hookworm and *Toxocara* infections in humans are considered public health concerns, and their impact does not only include individual health but also the socio-economic impacts of the worm burden are undeniable.

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