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Review Article

Human Toxocariasis: Secondary Data Analysis

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Keywords
- Toxocariasis
- Serological diagnosis
- Clinical symptoms
- Epidemiology
- Treatment

Abstract

Introduction: Toxocariasis is a helminthiasis caused by *Toxocara* ssp., and result of the migration of infective larvae into the visceral, causing disease. There are 21 species belonging to the *Toxocara* genus, but only *T. canis* and *T. cati* are important in public health.

Objetctive: To produce a review of the literature about human toxocariasis using the methodology of secondary data analysis. The aspects approached were morphobiological, immunological, pathological, clinical, and epidemiological to comprehend the evolution and therapeutical procedures of this helminthiasis.

Methods: The search period of the articles covered the last 70 years. Publications in different languages took part on the review and they are available online. The sources used to obtain these documents were Mediline, Lilacs, PubMed, Google Scholar, and SciELO. The key words used to select the scientific documents were *toxocariasis, T. canis* and *T. cati,* epidemiology, clinical diagnosis, serological diagnosis, clinical symptoms, and treatment.

Results: 217 complete articles entered the review; they were all related to human. Conclusions: Human toxocariasis occurs in various countries; however, the data on this disease are fragmented, requiring publications that gather all data about the morphology, clinical symptoms, immunological response, diagnosis, treatment, epidemiology and control of this parasitosis. The real frequency of this disease is yet unknown worldwide as there are no studies on human toxocariasis in all countries. The techniques for diagnosis are limited, lacking an easy access kit for the diagnosis with high specificity and sensitivity for the disease.

INTRODUCTION

Human toxocariasis is a parasitic zoonosis with a worldwide distribution but is under diagnosed with an under estimated impact on human health. In addition, the Centers for Disease Control and Prevention (CDC) considers this parasitosis among the five parasitic diseases that require public health actions [1,2]. Serologic studies in children have shown prevalence rates of greater than 50.6% [3] and in adults the prevalence rate is 8.7% [4].

The toxocariasis [5] is a syndrome that is a result of the prolonged migration of larvae of helminthic enteroparasites, common in domestic animals. Once in the organism of other animal species, including humans are doomed to die after a long stay in the viscera, not able to reach the adult stage [6-10]. This helminthiasis affects the man in several regions of the world, where dogs and cats are found on beaches, playgrounds and places in which the soils are exposed to these animal's feces [11,12] or owners of domestic cats and dogs [13].

There are several species of *Toxocara* [14-16] involved in the larva migrans syndrome, such as: *Toxocara canis* [17], *T. cati* [18,19], *T. malaysiensis* [20], *T. vitulorum* [21], and *T. leonina* [22,23] have been described in different regions of the world. However, among the species of the *Toxocara* genera responsible for human toxocariasis, *T. canis* and *T. cati* are the most important ones [24,25]. These helminths infect dogs and cats respectively. They are distributed worldwide, and animals of low age and nonimmune are of fundamental importance in the epidemiology of toxocariasis, as they are born hosting high quantities of parasite acquired via transplacental, and from the first days of life releasing hundreds of eggs into the environment contaminating it [26].

In soil, if temperature, oxygenation, and soil type are adequate, the eggs become larvae and infectious (eggs with larvae L3) [27,28]. People might get infected and acquire toxocariasis by different ways, such as; placing contaminated hands in the mouth and ingesting eggs, contaminating food with infected hands, eating fruits and vegetables poorly sanitized, eating raw meat from paratenic hosts with infective larvae of *Toxocara* spp., drinking water contaminated with larval eggs [29-31].

The infections caused by *Toxocara* spp. may be asymptomatic or symptomatic. In symptomatic cases, parasitosis can be severe, and generate irreparable sequel for individuals such as partial or total blindness, neurological problems, etc. [8,32].

The disease consists of the migration of larvae of the nematode parasites common to the animals, but in the human body, these evolutionary forms of helminths migrate through the viscera or through the eyeball, without completing their biological cycle. During the larvae´s lifetime inside the individual, they produce and release large amounts of antigens which triggers an intense inflammatory process in the host [33,34] as well as the characteristic symptoms of toxocariasis.

In many countries of the world as well as in Brazil, it is common for the population to have dogs and cats as pets [35]. These animals are kept at home as family members. They live inside homes or apartments, and usually, when these animals need to fulfill their physiological needs, they are led to walk the streets, playgrounds, and gardens. On these places, such animals defecate and urinate creating a serious problem when their owners do not collect their wastes, possibly *Toxocara* positive, giving it the correct destination.

The exposure of population to *Toxocara* spp. demonstrates the need for attention for the completion of clinical diagnosis parameters, as well as, the expansion of highly specific serological studies in different regions to understand the impact of toxocariasis.

There is a need for studies on complementary data such as morphobiological characteristics and epidemiological aspects, clinical, pathological, immunological, diagnosis, treatment and the control.

Articles that entered the review were obtained from the following data sources: LILACS, MEDLINE, PubMed, Google Academic, and SciELO.

The objective of the review was to verify the distribution of human toxocariasis in Brazil and in the world in the last 70 years, showing the morphobiological characteristics and epidemiological aspects of the etiological agents *T. canis* and *T. cati*, clinical, pathological, immunological, diagnosis, treatment and the control of this helminthiasis.

MORPHBIOLOGICAL AND EPIDEMIOLOGICAL CHARACTERISTICS OF *TOXOCARA CANIS* AND *T. CATI*

Morphological and biological characteristics of *T. canis* and T. cati

The nematode *Toxocara canis* (WERNER, 1782) [36] is the main intestinal parasite of canids, and *T. cati* (SCHRANK, 1788) [37] of felids. Both species cause infections in domestic and wild animals. These helminths belong to the Nematoda Phylum, Secernentea class, Ascaridida order, and Ascarididae family [38], *Toxocara* genus. This genus covers more than 21 species, being two of them of fundamental importance in public health: *T. canis* parasito of the canids: dogs, wolves, foxes, etc., and *T. cati* of felines: cats, leopard, etc. [39-44], being, therefore, a zoonosis of universal importance [43-46].

T. canis and *T. cati* present three evolutionary forms: adult males and females, eggs and larvae [45-49]. The morphological characteristics of these two species are similar. Both helminths present clear sexual dimorphism, and with considerable size. Adult males reach 3 to 10 cm, depending on the species and parasitic load that the definitive host holds. They have the posterior region ventrally curved (Table 1, Figure 1 A and B, Figure 2 A). Adult females present a variable size from 10 to 15 cm length and a tapered posterior region (Table 1, Figure 1 C and D, Figure 2 B). The sizes of the adult worms depend on the *Toxocara* species and the parasite load per host [38,49].

In addition, adult worms reveal common features such as milky color, three large lips around the mouth and the presence of two fin-shaped cervical alae that vary in shape and size depending on the species of *Toxocara* (Figure 3A), the *T. canis* and *T. cati*, respectively [38, 49,51-54].

The female's genitals begin in the anterior region and extend to the posterior one, in the vulvar region. The male's tail has a slender terminal appendix and caudal wings. The spicules measuring between 0.75 and 0.95 mm [15,38, 49,54].

The eggs are large and they are eliminated in the feces of the definitive hosts (dogs and cats). In *T. canis*, the average size of the eggs ranges from 75 to 90 micrometers, and in *T. cati*, from 65 to 70 μm [36,48,49,53]. These eggs possess a thick membrane that provides the eggs great resistance to the adverse conditions of the environment. The females of both helminths release about 200,000 eggs per day. They become infective within 2 to 3 weeks with larvae in the L3 stage [38,49,54-57], as shown in Figure 4 (A and B). Studies demonstrate that these eggs are extremely resistant to the action of chemicals and physical agents. Also resistant to temperature variations, remaining viable of infection for years [58-66].

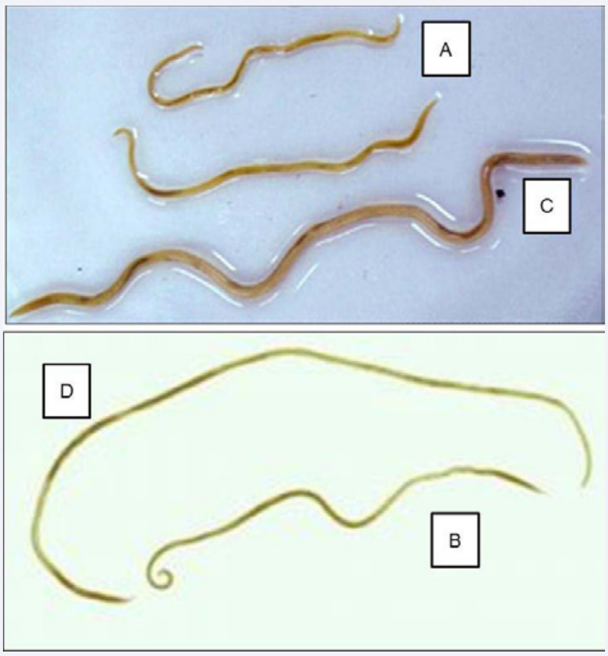

Figure 1 Morphology of adult worms: males (A and B), females (C and D) of *T. canis* and *T. cati* respectively. Source [48].
Viewed on the site: http://www.facmed.unam.mx/deptos/microbiologia/parasitologia/larva-migrans-visceral.html

Table 1: Differences in morphological characteristics of adult worms, eggs, and larvae of *T. canis* and *T. cati* species.

Evolutionary forms	Morphological characteristics	*T. canis*	***T. cati***
Adults	Males	4 - 6 cm	3 - 6 cm
	Females	15 cm	10 cm
Eggs	*T. canis*: Spherical shape	75 - 90 µm (diameter)	65 - 70 µm (diameter)
	T. cati: Elongated shape		
3rd stage larvae (infectious)	*T. canis*: Size length per diameter	About 0,5 mm/0,02 mm	About 0,4 mm/0,02 mm
	T. cati: Size length per diameter		

The biological cycle of these helminths is quite complex and the age of the definitive host is related to the transmission of the infection which might be transplacental, transmammary and by ingestion of paratenic hosts infected with third stage larvae [36,38,49,67-69]. In dogs up to three months of age, tracheal migration occurs [36,49,55,70], although some authors disagree with this timing, indicating that this migratory route can occur in animals up to six months of age [38]. Paratenic hosts acquire this parasitosis by ingesting infective eggs present in the soil, water, food and dirty and contaminated hands placed in the mouth. Also from meat of paratenic hosts infected with *Toxocara* spp. larvae [38,71], as shown in Figure 5.

The life cycle of *Toxocara* is monoxenic. Dogs and cats ingest larval eggs that are submitted to the action of the gastric juice and stimulate the exit of infective larvae (L3) in the small intestine. These larvae penetrate the intestinal mucosa, fall into the bloodstream, pass through the liver, heart, and reach the lungs. In the lungs, the L3 larvae make a molt and transform into L4 larvae. These larvae rupture the blood vessels, fall into the alveoli and rise through the trachea, being swallowed in the sequence. Once they reach the small intestine, they attach themselves to the intestinal mucosa and grow into male and female worms. Adult males and females copulate. The females release their eggs in the feces, which will contaminate the environment [49,55], as shown in Figure 5 [38,49,55].

The biological cycle of *T. canis* in animals and in man, in other words, begins with the ingestion of eggs with the L3 larvae. The eggs hatch and eliminate larvae in the small intestine. After that, these larvae enter the intestinal mucosa and blood or lymphatic pathways reaching the liver, lungs, brain, eyes, bone marrow, and lymph nodes. In humans, L3 larvae do not experience ecdises, remaining in the form of L3 at these sites. The life span of the larvae in these organs varies from weeks to months [38,49,55], as shown in Figure 6.

The long stay of the larvae in the tissues, the ingestion of food by them and the synthesis and release of secretions in the paratenic hosts induce the formation of an intense inflammatory process characterized by the presence of eosinophils, macrophages, mast cells, and formation of granulomas [72-81]. These processes are responsible for the clinical and pathological manifestations in these individuals.

The infection of the definitive hosts, dogs and cats, and paratenic hosts by *T. canis* and *T. cati*, is worldwide. However, the true dimension of the parasitosis is not yet fully known [24,82-85].

Epidemiological aspects of *T. canis* and T. cati

Toxocariasis is a global public health problem [38,49,82-85]. The number of research related to this topic has increased over the last decades; however, due to the magnitude of the disease for man, the number of studies related to it remains low. There are three factors considered obstacles to the achievement and dissemination of the results: First: the similarity of symptoms to other diseases, including other helminthiasis [32,33,72-79,81]. Second: the diagnosis difficulties, since there are no standardized kits with high sensitivity and specificity for the disease [86]. Third: the lack of control programs for this disease [24,49,78,83-85].

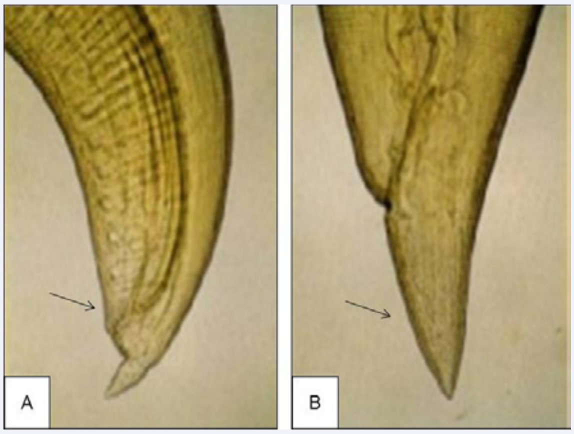

Figure 2 Morphology of the posterior regions of adults male (A) and female (B) worms of the genus *Toxocara*. Source [48,49].
Viewed on site: http://animaldiversity.ummz.umich.edu/site/accounts/information/*Toxocara*_canis.html

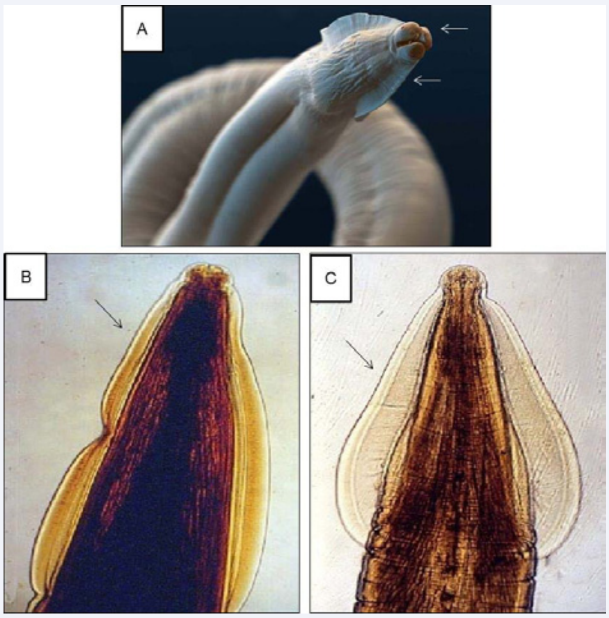

Figure 3 Morphology of anterior (A) regions common and present in adult worms of the *Toxocara* genus. Figures (B and C) show the cephalic wings presented in male and female adult worms of *T. canis* and *T. cati*, respectively [15,36,48,49].

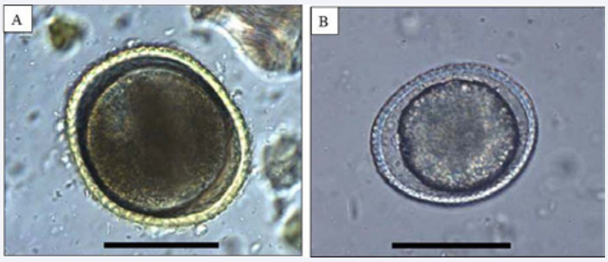

Figure 4 Eggs morphology (A) of *T. canis* and (B) of *T. cati* [60].

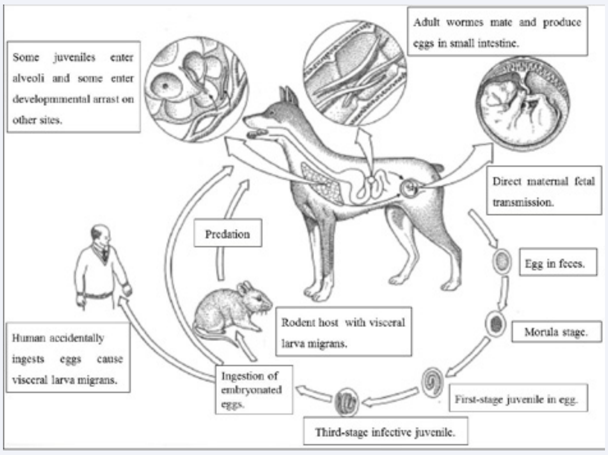

Figure 5 Evolutionary cycle of *T. canis* in the definitive host the dog. The other species of the *Toxocara* genus have a similar life cycle [38,49,55].
Viewed on site:
https://www.google.com.br/search?q=ciclo+de+vida+toxocara+e+cao&tbm=isch&imgil=zQR0bikIEg-bM:

In all continents, this helminthiasis is directly related to the sources of infection, which are dogs and cats [87-95]. The coexistence of man with these animals and the precarious hygienic habits of pet owners while handling them on already contaminated soil are contributors to the spread of the disease [93-98].

Dogs and cats with a few months of age (two or three) are the most infected, but as they grow older, they become more resistance to toxocariasis [49,55,99]. Concerning the gender, there is no consensus if male is more infected than females. In some work show that males are more susceptible than the females [49,55], but in other articles do not show significant differences [100]. The frequency of *T. canis* in dogs and *T. cati* in cats vary greatly from region to region in different countries. However, on all continents the animals harbor about a dozen females, which produce about 200,000 eggs daily [49,54-57], released into the environment.

It is important to emphasize that the coexistence between Man and the animals is not the main source for toxocariasis. This parasitosis is acquired by man when placing in the mouth larvae eggs of *T. canis* and *T. cati*, water or food [29,30,31,94,101-105] contaminated with soils polluted with feces of dogs and cats [106-110].

The eggs of *Toxocara* spp. [49,55] can remain viable for months in the soil if the climatic conditions of the environment is favorable with temperature between 18º to 30ºC, high relative humidity, no direct light action and oxygenated soil [49,55,59,60,95,106,107]. Under these conditions, the eggs need 9 to 15 days to produce infective larvae inside and become embryonated (stage 3). Eggs do not develop themselves into an embryo at temperatures below 12°C [49,55,59,60,95,103,104].

All people can be infected with *Toxocara* spp. eggs. However, children between two and five years of age are the most infected due to their precarious hygienic conditions since they are most of the times with dirty hands, and always putting them in the mouth [49,92,108-110].

The enzootic cycle of *T. canis* in dogs is ensured mainly by congenital transmission, in the prenatal period [111]. In cats, transmission by infective eggs present in the soil occurs. There are animals that ingest larvae eggs from the soil and feed cats such as earthworms, cockroaches, and mice [49]. These animals also generate infection. The transplacental transmission of *T. cati* to the offspring, so far is not conclusive [56,64,71,99,108-111] however it can occur.

Another form of acquisition of *Toxocara* by man is the ingestion of raw or undercooked meat of paratenic helminth animals such as birds [101,102], bovine [112], oysters [113], or contaminated vegetables [94,105].

In developing countries, some factors have contributed a lot to the increasing number of animals in contact with humans. Housing conditions have increased closer and more frequent contact of domestic animals and their owners. In addition, movements of ecologists resulted in individuals that are more conscious and better informed of the policies of protection and preservation of

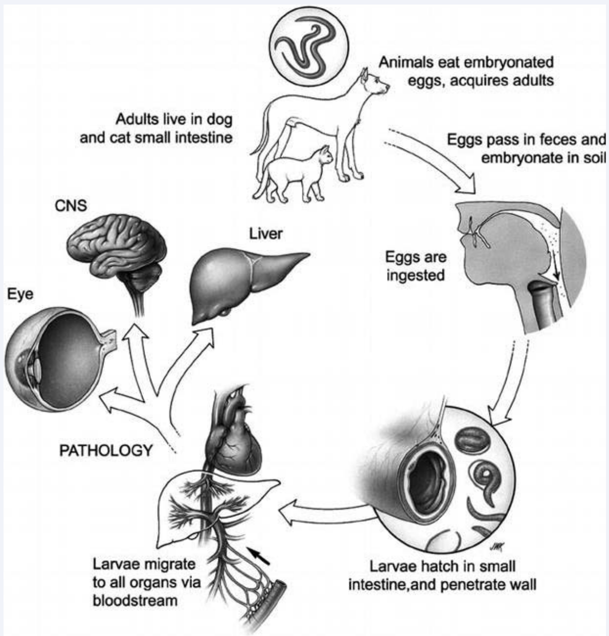

Figure 6 Evolutionary cycle of *T. canis* in parantennial hosts (Adapted: [38]. The other species of the *Toxocara* genus have a similar life cycle [49,55].

animals. On the other hand, there are no government actions to inform the population about the risks of disease transmission, or the control of zoonoses transmitted by domestic animals. There is no initiative towards the control of populations of stray animals on the streets. Thus, these facts result in an increased risk of human exposure to zoonoses transmitted by animals such as dogs and cats [16,20,25,30,49,114,115].

The human infection with *Toxocara* spp. results from the ingestion of infective eggs of *T. canis* and *T. cati* present in soil contaminated with feces of dogs and cats respectively. The prevalence of canine and cat intestinal infection may be an indicator of the risk of human infection in different areas, both urban and rural [61,66,71,91,96,100,109,110,115].

Some studies have evaluated the levels of environmental contamination, mainly in public areas, through analysis of soil, sand, and feces samples from domestic, urban and rural centers. They revealed a strong correlation with human infection [49,55,91,107-110]. In other studies about the frequency of seropositive for *T. canis* antigens, they show high rates, especially in children living in more needy communities [114,116,117], and in areas populated by dogs and cats [118].

The frequency of infected people results from seroprevalence surveys conducted in different regions of the world, using different methodologies for the diagnosis. The data of these studies demonstrates that the rates of parasitism vary between different countries such as: 4.6% to 7.3% in United States [82], 3.4 % in Japan [119], 7.0% in Sweden [120], 35.6 % in Peru [121], 47.5% in Colombia [122], and 86.0% in Caribbean [123]. Research results using serological tests suggest that about 7.0% of the clinically healthy human population of the United States, about 5.0% of that Canada, and about 4.0% of that in Great Britain is infected with the *Toxocara* spp. [124]. Yet, these data are punctual, although they come from few counties in each country, being, therefore poorly noticed.

In Brazil, a number of studies show that toxocariasis varies from 4.2% to 91.4%, depending on the type of sample and method used, and the socioeconomic level of the sample population [125,126]. The frequency of infection with *Toxocara* spp., in patients examined by the Immunoenzymatic method (ELISA) in Brazil varies from state to state such as: São Paulo from 3.6% to 38.8% [127,128], Pernambuco from 12.1% to 40.0% [129,130], Minas Gerais from 8.7% to 19.6% [131, 132], Paraná from 17.8% to 56.0% [133,134], Brasília from 21.8% to 26.0% [116,135].

Study conducted in Brazil show a variation of positivity for toxocariasis between children and adults. These studies in children revealed high *Toxocara* spp. seroprevalence (IgG), with rates varying from 3.0% to 90.0% [3,136,137]. Furthermore, few studies involving adults recorded rates below 8.7% [4], 6.4% [138] and 14.9% [139].

Currently, with the development of the ELISA technique using *Toxocara* ssp. secreted and excreted (TES) the sensitivity and specificity of the diagnosis of the infection has increased. This will permit the execution of seroepidemiological studies for toxocariasis, elucidating accurately the frequency of this disease in Brazil and worldwide, and lead to the development of new strategies for diagnostics or vaccination [140].

Pathological aspects, clinical and immunological symptoms of toxocariasis

The typical lesion produced by the larvae of *Toxocara canis* and *T. cati* is the formation of allergic granuloma around the infective larva (L3) of the parasite [141]. In the central region of the granuloma, there is the L3 and necrotic tissue with fibrinogen degeneration surrounded by eosinophils and monocytes [142]. In addition, in the granuloma region, there are the fibroblasts that participate in the fibrotic capsule formation. There are also giant cells there. Some larvae may incrust and remain viable for several months in the host [83,143].

Clinical symptoms

The severity of the clinical symptoms of people with VLM is variable and depends on factors such as: Location and number of larvae present in the body, as well as the immune response of infected persons [83,144,145].

The individual infected with a low number of larvae is usually asymptomatic [83,146]. However, people who have reinfections or ingest large numbers of eggs, clinical symptoms are evident [147]. In human infections are by larvae of *Toxocara* spp. The disease is also known as visceral migrans larvae (VLM), as described in the literature [83], and depending on the affected viscus, they are given specific names such as visceral toxocariasis (VLM), ocular toxocariasis or OLM, and occult or atypical toxocariasis [148].

The clinical manifestations of the disease are hepatomegaly, fever, and respiratory problems [149,150-152]. In smaller proportions, patients complain of digestive problems, asthenia, malnutrition, brain involvement, splenomegaly, anorexia, pallor, cutaneous signs, adenopathies, endocarditis, and persistent eosinophilia [153-155].

Respiratory symptoms are frequent and characterized by coughing, wheezing, pulmonary infiltrates, and sometimes nodules [156-158]. Some patients present Central Nervous System (CNS) impairment, convulsive crisis, and behavioral disorder [49,55,159].

Ocular toxocariasis (OLM) characteristic are a decreased ability to see, ocular pain, and strabismus [160]. In addition, the changes are compatible with uveitis, papillitis with or without granuloma in the eyes, cataract, and when undiagnosed in time, parasitism can lead to blindness [160-163].

In atypical or occult toxocariasis, the patient presents with abdominal and lower limb pains, headache, intense and prolonged asthenia and hepatomegaly [161,162,164].

Thereby, the symptoms presented by individuals are related to where the larvae are migrating or encysted [49,55].

Immunological aspects of toxocariasis

The larvae of *Toxocara* spp. establish an intimate interaction with the human or animal parantennial host. The presence of the larvae in the tissues and substances secreted and excreted by them activate the mechanisms of humoral and cellular immunity [165,166].

The cellular immune response is present in the formation of the granuloma around the larvae [143]. However, it is yet unclear whether it is dependent or not dependent on eosinophils or the interference of the specific IgE antibody [146,167].

The granuloma made around the infective larvae does not kill it, but forms a protection around them. They remain active for many months in the tissues, producing and releasing glycosylated antigenic substances, which induce an immunological response with increase of circulating eosinophils and elevation of IgE and IgG levels [168,169]. It is not known for how long the larvae remain viable, but it is believed that they can remain alive within the granuloma for a relatively long time, around five years [49,55].

Data from the literature show that larvae of *Toxocara spp.* once in the liver and lungs induce the formation of granulomas around them. In this inflammatory process the number of peripheral leukocytes, circulating and tissue eosinophils, IgE and IgG antibodies, cytokines such as IL-4 and IL-10 are increased [170,171]. Other IL-6 and IL-13 cytokines showed elevated serum levels of *Toxocara* in infected children [172]. Circulating antibodies of the toxocariasis remain elevated during the time that the larvae remain alive, but as they are eliminated from the body, these substances gradually subside until they reach the basal levels of a normal person.

DIAGNOSIS, TREATMENT, AND TOXOCARIASIS CONTROL

Diagnosis

The diagnosis of toxocariasis is difficult, since the certainty of parasitism consists in the finding and identification of the larvae in the tissues [77,173].

The diagnosis of VLM is based on the clinical and hematological symptoms and in the biopsy, which allows visualization of the larvae in the eosinophilic granulomas [149,174].

Histological examinations are mostly inconclusive due to the difficulty of finding the larvae in the suspected tissue [49,55,144]. This technique is not used so often because it is invasive and the amount of material obtained is very small. It also may not be able to catch the larva in the fragment used.

Thus, for the diagnosis of VLM should consider the individual's history as age, reports of geophagy, contact with dogs and cats, clinical symptoms as well as laboratory results of the patient such as increased numbers of circulating and persistent tissue eosinophils, hypergammaglobulinemia and increased concentrations of antibodies: IgM, IgE and IgG. These parameters, although indicative of VLM, can be confused with other parasitic infections such as ascariasis, schistosomiasis, strongyloidiasis, fasciolosis, asthma among others [175,176], therefore, must be differentiated.

The imaging methods used in the diagnosis of VLM consist on locating the granulomas around the larvae of *Toxocara*. The most commonly used methods are ultrasonography and computerized tomography of the abdomen, where areas in the liver and the lungs occupied by the larvae, etc. are visualized [177]. In the lesions of the central nervous system (CNS), magnetic resonance imaging is utilized, with granulomas being clearly visible [178].

Ocular toxocariasis (OLM) is diagnostic based on funduscopic ophthalmic exams; however, it must be differentiated from other ocular diseases such as retinoblastoma, exudative retinitis (Coat's disease), trauma and other uveitis [49,55]. These examinations should consider the unilocular process, morphological and topographic aspect of the lesions [179]. Another method used to visualize *Toxocara* larvae in the eyes is ultrasonography, where it shows the larvae involved by the granuloma and the displacement of the retina [173].

Toxocariasis can be diagnosed by means of serological tests, which allows the detection of specific anti-*Toxocara* antibodies in infected individuals. Larvae of this helminth activate the humoral immune response and the antibodies commonly detected are specific IgA, IgE, and IgG [180-182].

In the research of these antibodies specific for *Toxocara* the Immunoenzymatic (ELISA) technic is recommended, using the antigen secreted and excreted by the larvae for the detection of IgG and IgE [144,183]. The use of secreted and excreted antigen from *T. canis* and *T. cati* present better specificity than those from somatic antigen Larvae source. However, it does not eliminate the cross reactivity with *Ascaris* sp*.* [184,185]. However, studies conducted in Brazil or other developing countries, the sera must be pre-adsorbed with other helminth antigens, particularly with *Ascaris* spp., to prevent cross-reactions [3,186,187]. It is important to note that the TES-ELISA, associated with the pre-adsorption methodology of sera with somatic antigen of *Ascaris* sp. (SoAs), is indicated to avoid or minimize cross-reactions with other helminths in tropical polyparasitism, such as Brazil [186].

In addition, IgG2 and IgG4 specific searches for *Toxocara* spp. have been performed to increase sensitivity [188], and specificity [189] of the serological test, respectively [144], and detection of IgG4 may mean infection active [189].

The ELISA technique used in the immunodiagnosis is the one that presents better sensitivity and specificity in relation to other techniques such as Immunofluorescence, Gel diffusion, Hemagglutination and Intradermoreação [92]. The Western blot technique can be used for the diagnosis of toxocariasis, especially for those patients who present chronic manifestations and have low antibody levels, since it is more sensitive than the ELISA [190].

The biological fluids used in the ELISA tests are serum, cerebrospinal fluid, and intraocular [191]. Such material may also be used in the Western blot technique for VLM and OLM [92].

Other non-specific laboratory findings that may suggest toxocariasis are global and specific leukometry, IgM, IgG, and IgE antibodies at high levels, persistent and high eosinophilia ranging from 50 to 90% of the cells. Stool examinations for this parasite are not used, as the eggs elimination does not occur once hosts do not harbor the adult worms [166,192].

Treatment

For the treatment of toxocariasis there is no proven effective therapeutic protocol, even if there are anthelmintic that act on *Toxocara* spp. larvae. Many authors consider that asymptomatic individuals, who have increased levels of anti-*Toxocara* and eosinophilia antibodies, should not be treated [145,193].

However, other researchers believe that asymptomatic individuals carrying larvae of this parasite in the tissue should be treated because they are at risk of developing toxocariasis ocular [194,195].

Patients with symptomatic toxocariasis should be treated and the course of the disease be monitored after treatment. There is no recommended treatment scheme in the literature. However, the choice of antiparasite should be directed to the affected organ. Thus, treatment should be directed to VLM or to OLM [91,146].

There are several anthelmintics for the treatment of VLM showing different degrees of safety and efficacy [146]. The most commonly used vermifuges are: albendazole, ivermectin, levamisole, thiabendazole, febendazole, mebendazole, diethylcarbamazine [178,196]. Of these seven drugs commonly used in the treatment of the disease, albendazole at the dose of 10 mg/kg/day for five days is the most indicated. It is the safest option with no side effects [83,174]. In addition, depending on the inflammatory clinical picture, an association between the vermifuges and an anti-inflammatory like corticosteroids should be administered to the patient [197,198].

The treatment of patients with VLM as well as administering anthelmintic, they should get corticosteroids to control the inflammatory lesions from the death of *Toxocara* larvae and release of parasitic antigens [144,199,200].

Many researchers believe that dewormers do not reach the larvae protected by granulomas; therefore, vermifugation is not necessary [201,202]. Another used procedure is photocoagulation in cases of granuloma of the posterior pole, and vitrectomy in cases of peripheral granulomas [49,55,202].

Control

Toxocariasis has a direct association with the presence of dogs and cats in places where humans can get infected such as beaches, parks, and public squares [203,204], and soils of residences in rural or urban area [123,204]. Sandboxes in day care centers, schools, and playgrounds can function as infection sites for children [205,206].

All people can get VLM but children are the most affected because they play on land and sand, coming in direct contact with the infecting eggs [207]. They place their dirty hands as well as objects in the mouth [207]. They also handle food when their hands are contaminated with the eggs of *Toxocara* spp. [49,55,207].

The number of cases of people with toxocariasis described in the literature is low in relation to the high number of dogs and cats infected with *Toxocara*. This is because the disease is underreported, since the symptoms are similar to other helminthiasis and the diagnosis is difficult [201,202].

Some researchers point out that the majority of cases of VLM occur in children with an average age of two years and the cases OLM in older children and adults [208,209]. In these two diseases, there is a strong historical relationship of geophagy and exposure to feces of dogs and cats. Furthermore, animals such as cattle, pigs, chickens are also paratenic hosts for *Toxocara.* So, ingestion of undercooked meat may be a source of infection for humans, particularly in some Asian countries that nurture the habit of eating raw liver of such animals [162,210].

Dogs and cats with a few weeks of age are considered the main source of infection, since they are born with high-acquired transplacental parasite load [68,201,202]. In some regions, the prevalence reaches 100%. Moreover, they eliminate a large number of eggs daily in the soil, which are highly resistant to environmental conditions [109,110].

Existing control measures for toxocariasis are; basic sanitation where dogs' feces need to be eliminated from the environment frequented by man such as parks, gardens, etc. [109]. Changes of habits such as handling contaminated soil with *Toxocara* eggs with unprotected hands, creating habits of keeping children's nails short, washing hands before handling food, washing vegetables well before eating them [211,212].

Places where people ingest meat or viscera in the raw state, it is important to educate them about toxocariasis and the need to cook these foods well in order to kill the parasite. Such changes would contribute to reducing the risks of infection [201,202]. The anthelmintic treatment of dogs and cats should be stimulated periodically to reduce soil contamination with the eggs of this ascarid [197,201,202]. It would also be important to induce people who own dogs and cats to collect their animals' feces and give them proper destination when they are disposed of on land or in areas of public housing [69,115,213].

Another efficient measure to reduce infections by this nematode would be to surround public parks preventing access of dogs and cats, thus reducing contamination of soils with positive feces to *Toxocara* spp. [214-217].

CONCLUSIONS

The clinical symptoms that human individuals with toxocariasis present are indicative of a helminthiasis and dependent on the location where the parasite is. However, none of the clinical manifestations presented by the infected person is specific and indicative of this parasitosis.

The diagnosis of a person with VLM is difficult, since the clinical manifestation of the disease is similar to the symptoms of other diseases. Thus, to differentiate them, it is necessary to carry out the differential diagnosis, and serological tests still are the most indicated.

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REFERENCES

1. Centers for Disease Control and Prevention (CDC). Parasites: Neglected Parasitic Infections. Toxocariasis. CDC 24/7: Saving Lives. Protecting People. Saving Money through Prevention.
2. Fialho PM, Corrêa CR. A Systematic Review of Toxocariasis: A Neglected But High-Prevalence Disease in Brazil. Am J Trop Med Hyg. 2016; 94: 1193-1199.
3. Schoenardie ER, Scaini CJ, Brod CS, Pepe MS, Villela MM, McBride AJ,

et al. Seroprevalence of *Toxocara* infection in children from southern Brazil. J Parasitol. 2013; 99: 537-539.

4. Negri EC, Santarém VA, Rubinsky-Elefant G, Giuffrida R. Anti-*Toxocara* spp. antibodies in an adult healthy population: serosurvey and risk factors in Southeast Brazil. Asian Pac J Trop Biomed. 2013; 3: 211-216.

5. Beaver PC, Snyder CH, Carrera GM, Dent JH, Lafferty JW. Chronic eosinophilia due to visceral larva migrans; report of three cases. Pediatrics. 1952; 9: 7-19.

6. Lescano SZ, Queiroz ML, Chieffi PP. Larval recovery of *Toxocara canis* in organs and tissues of experimentally infected Rattus norvegicus. Mem Inst Oswaldo Cruz. 2004; 99: 627-628.

7. Salvador S, Ribeiro R, Winckler MI, Ohlweiler L, Riesgo R. Pediatric neurotoxocariasis with concomitant cerebral, cerebellar, and peripheral nervous system involvement: case report and review of the literature. J Pediatr (Rio J). 2010; 86: 531-534.

8. Allahdin S, Khademvatan S, Rafiei A, Momen A, Rafiei R. Frequency of Toxoplasma and *Toxocara* Sp. Antibodies in Epileptic Patients, in South Western Iran. Iran J Child Neurol. 2015; 9: 32-40.

9. Akdemir C. Visceral larva migrans among children in Kütahya (Turkey) and an evaluation of playgrounds for *T. canis* eggs. Turk J Pediatr. 2010; 52: 158-162.

10. Chorazy ML, Richardson DJ. A survey of environmental contamination with ascarid ova, Wallingford, Connecticut. Vector Borne Zoonotic Dis. 2005; 5: 33-39.

11. Berenji F, Pouryousef A, Fata A, Mahmoudi M, Salehi M, Khoshnegah J. Seroepidemiological Study of Toxocariasis in the Owners of Domestic Cats and Dogs in Mashhad, Northeastern Iran. Iran J Parasitol. 2016; 11: 265-268.

12. Poulle ML, Bastien M, Richard Y, Josse-Dupuis É, Aubert D, Villena I, et al. Detection of Echinococcus multilocularis and other foodborne parasites in fox, cat and dog faeces collected in kitchen gardens in a highly endemic area for alveolar echinococcosis. Parasite. 2017; 24: 29.

13. Fan CK, Holland CV, Loxton K, Barghouth U. Cerebral Toxocariasis: Silent Progression to Neurodegenerative Disorders? Clin Microbiol. 2015; 28: 663-686.

14. Li MW, Lin RQ, Song HQ, Wu XY, Zhu XQ. The complete mitochondrial genomes for three *Toxocara* species of human and animal health significance. BMC Genomics. 2008; 9: 224.

15. Chen J, Zhou DH, Nisbet AJ, Xu MJ, Huang SY, Li MW, et al. Advances in molecular identification, taxonomy, genetic variation and diagnosis of *Toxocara* spp. Infect Genet Evol. 2012; 12: 1344-1348.

16. Khademvatan S, Abdizadeh R, Tavalla M. Molecular characterization of *Toxocara* spp. from soil of public areas in Ahvaz southwestern Iran. Acta Trop. 2014; 135: 50-54.

17. Kambe D, Takeoka K, Ogawa K, Doi K, Maruyama H, Yoshida A, et al. Treatment-resistant neuromyelitis optica spectrum disorders associated with *Toxocara canis* infection: A case report. Mult Scler Relat Disord. 2017; 13: 116-118.

18. He X, Lv MN, Liu GH, Lin RQ. Genetic analysis of *Toxocara cati* (Nematoda: Ascarididae) from Guangdong province, subtropical China. Mitochondrial DNA A DNA Mapp Seq Anal. 2017; 31: 1-4.

19. Iddawela D, Ehambaram K, Bandara P. Prevalence of *Toxocara* antibodies among patients clinically suspected to have ocular toxocariasis: A retrospective descriptive study in Sri Lanka. BMC Ophthalmol. 2017; 17: 50.

20. Le TH, Anh NT, Nguyen KT, Nguyen NT, Thuy do TT, Gasser RB. *Toxocara* malaysiensis infection in domestic cats in Vietnam--An emerging zoonotic issue? Infect Genet Evol. 2016; 37: 94-98.

21. Iddawela D, Ehambaram K, Bandara P. Prevalence of *Toxocara* antibodies among patients clinically suspected to have ocular toxocariasis: A retrospective descriptive study in Sri Lanka. BMC Ophthalmol. 2017; 17: 50.

22. Jin Y, Shen C, Huh S, Choi MH, Hong ST. Cross-reactivity of Toxocariasis with Crude Antigen of Toxascaris leonina Larvae by ELISA. J Korean Med Sci. 2015; 30: 549-551.

23. Redman WK, Bryant JE, Ahmad G. Gastrointestinal helminths of Coyotes (Canis latrans) from Southeast Nebraska and Shenandoah area of Iowa. Vet World. 2016; 9: 970-975.

24. Azam D, Ukpai OM, Said A, Abd-Allah GA, Morgan ER. Temperature and the development and survival of infective *Toxocara canis* larvae. Parasitol Res. 2012; 110: 649-656.

25. Zibaei M, Abdollahpour F, Birjandi M, Firoozeh F. Soil contamination with *Toxocara* spp. eggs in the public parks from three areas of Khorram Abad, Iran. Nepal Med Coll J. 2010; 12: 63-65.

26. Epe C, Meuwissen M, Stoye M, Schnieder T. Transmission trials, ITS2-PCR and RAPD-PCR show identity of *Toxocara canis* isolates from red fox and dog. Vet Parasitol. 1999; 84: 101-112.

27. Campos-da-Silva DR, da Paz JS, Fortunato VR, Beltrame MA, Valli LC, Pereira FE, et al. Natural infection of free-range chickens with the ascarid nematode *Toxocara* sp. Parasitol Res. 2015; 114: 4289-4293.

28. Vargas C, Torres P, Jercic MI, Lobos M, Oyarce A, Miranda JC, et al. Frequency of anti-*Toxocara* spp. antibodies in individuals attended by the centro de salud familiar and environmental contamination with *Toxocara canis* eggs in dog feces, in the coastal niebla town, Chile. Rev Inst Med Trop Sao Paulo. 2016; 58: 62.

29. Polo GA, Benavides CJ, Astaiza JM, Vallejo DA, Betancourt P. Enteroparasite determination in Lactuca sativa from farms dedicated to its production in Pasto, Colombia. Biomedica. 2016; 36: 525-534.

30. Otake Sato M, Sato M, Yoonuan T, Pongvongsa T, Sanguankiat S, Kounnavong S, et al. The role of domestic dogs in the transmission of zoonotic helminthes in a rural area of Mekong river basin. Acta Parasitol. 2017; 62: 393-400.

31. Zibaei M, Sadjjadi SM, Maraghi S. The occurrence of *Toxocara* species in naturally infected broiler chickens revealed by molecular approaches. J Helminthol. 2017; 91: 633-636.

32. Vidal JE, Sztajnbok J, Seguro AC. Eosinophilic meningoencephalitis due to *Toxocara canis*: case report and review of the literature. Am J Trop Med Hyg. 2003; 69: 341-343.

33. Tau AH, Vizcaychipi KA, Cabral DH, Maradei JL, Ferreyra AH, San Sebastián EI. Eosinophilic ascites secondary to toxocariasis. Acta Gastroenterol Belg. 2015; 78: 336-339.

34. Despreaux R, Fardeau C, Touhami S, Brasnu E, Champion E, Paris L, et al. Ocular Toxocariasis: Clinical Features and Long-term Visual Outcomes in Adult Patients. Am J Ophthalmol. 2016; 166: 162-168.

35. Domingues LR, Cesar JA, Fassa AG, Domingues MR. [Responsible pet animal guardianship in the urban area of the municipality of Pelotas in the state of Rio Grande do Sul, Brazil]. Cien Saude Colet. 2015; 20: 185-192.

36. Sprent JF. Observations on the development of *Toxocara canis* (Werner, 1782) in the dog. Parasitology. 1958; 48: 184-209.

37. Sprent JF. The life history and development of *Toxocara cati* (Schrank 1788) in the domestic cat. Parasitology. 1956; 46: 54-78.

38. Schmidt GD, Roberts LS. Nematodes: Ascaridomorpha, intestinal large roundworms In: Foundations of Parasitology. Chapter 26. 8th edn, Ed. McGrawHill, 2009; 433-441.

39. Yasuda N, Akuzawa M, Maruyama H, Izawa M, Doi T. Helminths of the Tsushima leopard cat (Felis bengalensis euptilura). J Wildl Dis. 1993; 29: 153-155.

40. Ferreira JI, Pena HF, Azevedo SS, Labruna MB1, Gennari SM1. Occurrences of gastrointestinal parasites in fecal samples from domestic dogs in São Paulo, SP, Brazil. Rev Bras Parasitol Vet. 2016; 25: 435-440.

41. Figueiredo A, Oliveira L, Madeira CL, Fonseca C, Torres RT. Parasite species of the endangered Iberian Wolf (Canis lupus signatus) and a sympatric widespread carnivore. Int J Parasitol Parasites Wildl. 2016; 5: 164-167.

42. Hermosilla C, Kleinertz S, Silva LM, Hirzmann J, Huber D, Kusak J, et al. Protozoan and helminth parasite fauna of free-living Croatian wild wolves (Canis lupus) analyzed by cat collection. Vet Parasitol. 2017; 233:14-19.

43. Uspenskiĭ AV, Peshkov RA, Gorokhov VV, Gorokhova EV. [Toxocariasis under the present conditions]. Med Parazitol (Mosk). 2011; 3-6.

44. Macpherson CN. The epidemiology and public health importance of toxocariasis: a zoonosis of global importance. Int J Parasitol. 2013; 43: 999-1008.

45. Kroten A, Toczylowski K, Kiziewicz B, Oldak E, Sulik A. Environmental contamination with *Toxocara* eggs and seroprevalence of toxocariasis in children of northeastern Poland. Parasitol Res. 2016; 115: 205-209.

46. Thomas D, Jeyathilakan N, Abdul Basith S, Senthilkumar TM. In vitro production of *Toxocara canis* excretory-secretory (TES) antigen. J Parasit Dis. 2016; 40: 1038-1043.

47. Mata-Santos T, D'Oca Cda R, Mata-Santos HA, Fenalti J, Pinto N, Coelho T, et al. *Toxocara canis*: Larvicidal activity of fatty acid amides. Bioorg Med Chem Lett. 2016; 26: 739-741.

48. Berrueta TU. Larva Migrans Visceral. Departamento de Microbiología y Parasitología, Facultad of Medicine, UNAM. 2016.

49. Rey L. Parasitology. 48 Chapter, 4 edn. Guanabara Koogan, 2010. 637-641.

50. Mikaeili F, Mirhendi H, Hosseini M, Asgari Q, Kia EB. *Toxocara* nematodes in stray cats from shiraz, southern iran: intensity of infection and molecular identification of the isolates. Iran J Parasitol. 2013; 8: 593-600.

51. Talluri MV, Paggi L, Orecchia P, Dallai R. Fine structure of buccal cavity and esophagus in *Toxocara canis* (Nematoda, Ascarididae) infective larvae. J Ultrastruct Mol Struct Res. 1986; 97: 144-157.

52. Schacher JF. A contribution to the life history and larval morphology of *Toxocara canis.* J Parasitol. 1957; 43: 599-610.

53. Okulewicz A1, Złotorzycka J. [*Toxocara canis* (Nematoda) and toxocariasis of animals and humans]. Wiad Parazytol. 1997; 43: 3-25.

54. Soulsby EJ. The evasion of the immune response and immunological unresponsiveness: parasitic helminth infections. Immunol Lett. 1987; 16: 315-320.

55. Coura JC. Dynamics of infectious and parasitic diseases. 88 Chapter, 1st edn. Editor. Guanabara Koogan, 2005; 1: 1071-1075.

56. Chowdhury N, Sood NK, Lal S, Gupta K, Singla LD. Development of some larval nematodes in experimental and natural animal hosts: an insight into development of pathological lesions vis-a-vis host-parasite interactions. Scientific World J. 2013; 23: 162538.

57. Strube C, Heuer L, Janecek E. *Toxocara* spp. infections in paratenic hosts. Vet Parasitol. 2013; 193: 375-389.

58. Nijsse R, Ploeger HW, Wagenaar JA, Mughini-Gras L. *Toxocara canis* in household dogs: prevalence, risk factors and owners' attitude towards deworming. Parasitol Res. 2015; 114: 561-569.

59. Korsholm E. [*Toxocara canis* as a cause of visceral larva migrans. Survival and development of eggs in the environment and potential ways of transmission to man: a review]. Nord Vet Med. 1982; 34: 1-12.

60. Gamboa MI. Effects of temperature and humidity on the development of eggs of *Toxocara canis* under laboratory conditions. J Helminthol. 2005; 79: 327-331.

61. Overgaauw PA. Aspects of *Toxocara* epidemiology: toxocarosis in dogs and cats. Crit Rev Microbiol. 1997; 23: 233-251.

62. Maya C, Ortiz M, Jiménez B. Viability of Ascaris and other helminth genera non larval eggs in different conditions of temperature, lime (pH) and humidity. Water Sci Technol. 2010; 62: 2616-2624.

63. Lee AC, Schantz PM, Kazacos KR, Montgomery SP, Bowman DD. Epidemiologic and zoonotic aspects of ascarid infections in dogs and cats. Trends Parasitol. 2010; 26: 155-161.

64. Glickman LT, Schantz PM. Epidemiology and pathogenesis of zoonotic toxocariasis. Epidemiol Rev. 1981; 3: 230-250.

65. Overgaauw PA. *Toxocara* infections in dogs and cats and public health implications. Vet Q. 1998; 20 Suppl 1: 97-98.

66. Kostopoulou D, Claerebout E, Arvanitis D, Ligda P, Voutzourakis N, Casaert S, et al. Abundance, zoonotic potential and risk factors of intestinal parasitism amongst dog and cat populations: The scenario of Crete, Greece. Parasit Vectors. 2017; 10: 43.

67. Rodríguez-Caballero A, Luna-Ochoa RI, Ponce-Macotela M, Peralata-Abarca GE, Martínez-Gordillo MN. A simple and inexpensive in vitro method for retrieving fertilized *Toxocara canis* eggs. Parasitol Res. 2007; 101: 829-832.

68. Coati N, Schnieder T, Epe C. Vertical transmission of *Toxocara cati* Schrank 1788 (Anisakidae) in the cat. Parasitol Res. 2004; 92: 142-146.

69. Telmo Pde L, Avila LF, Santos CA, Aguiar Pde S, Martins LH, Berne ME, et al. elevated trans-mammary transmission of *Toxocara canis* larvae in BALB/c mice. Rev Inst Med Trop Sao Paulo. 2015; 57: 85-87.

70. Flecher MC, Musso C, Martins IV, Pereira FE. Larval migration of the ascarid nematode *Toxocara canis* following infection and re-infection in the gerbil Meriones unguiculatus. Helminthol. 2016; 90: 569-576.

71. Jarosz W, Mizgajska-Wiktor H, Kirwan P, Konarski J, Rychlicki W, Wawrzyniak G. Developmental age, physical fitness and *Toxocara* seroprevalence amongst lower-secondary students living in rural areas contaminated with *Toxocara* eggs. Parasitology. 2010; 137: 53-63.

72. Despommier D. Toxocariasis: clinical aspects, epidemiology, medical ecology, and molecular aspects. Clin Microbiol Rev. 2003; 16: 265-272.

73. Ecevit Ç, Bağ Ö, Vergin C, Öztürk A. Visceral larva migrans presenting with hypereosinophilia. Turkiye Parazitol Derg. 2013; 37: 58-60.

74. Sangen H, Tanabe J, Takano H, Shimizu W. Successful early diagnosis and treatment in a case of *Toxocara canis*-induced eosinophilic myocarditis with eosinophil-rich pericardial effusion. BMJ Case Rep. 2015; 3: 2015.

75. Karagöz E, Selek MB, Aydin E, Hatipoglu M, Turhan V, Acar A, et al. Recurrent toxocariasis due to chronic urticaria and successful

treatment with prolonged albendazole therapy. Turkiye Parazitol Derg. 2015; 39: 83-85.

76. Janecek E, Beineke A, Schnieder T, Strube C. Neurotoxocarosis: marked preference of *Toxocara canis* for the cerebrum and T. cati for the cerebellum in the paratenic model host mouse. Parasit Vectors. 2014; 7: 194.

77. Heuer L, Beyerbach M, Lühder F, Beineke A, Strube C. Neurotoxocarosis alters myelin protein gene transcription and expression. Parasitol Res. 2015; 114: 2175-2186.

78. Lalosević D, Oros A, Lalosević V, Knezević K, Knezević S, Bozić K , et al. [Manifestations of visceral and ocular symptoms of toxocariasis in a 6-year-old boy]. Med Pregl. 2001; 54: 51-53.

79. Dutra GF, Pinto NS, De Avila LF, Dutra PC, Telmo PDE L, Rodrigues LH, et al. Eosinophilic meningitis caused by Angiostrongylus cantonensis: an emergent disease in Brazil. Mem Inst Oswaldo Cruz. 2014; 109: 399-407.

80. Morales MS, Tartarella MB, Gouveia EB, Mandello MH, Allemann N. Ophthalmic Doppler in persistent hyperplastic primary vitreous atypical presentation: case report. Arq Bras Oftalmol. 2015; 78: 320-322.

81. Zibaei M, Sadjjadi SM, Jahadi-Hosseini SH. *Toxocara cati* larvae in the eye of a child: a case report. Asian Pac J Trop Biomed. 2014; 4: 53-55.

82. Hotez PJ, Wilkins PP. Toxocariasis: America's most common neglected infection of poverty and a helminthiasis of global importance? PLoS Negl Trop Dis. 2009; 3: e400.

83. Oryan A, Alidadi S. Toxocariasis: A Neglected Parasitic Disease with Public Health Importance. Trop Med Surg. 2015; 3: 126.

84. Moreira GM, Telmo PL, Mendonça M, Moreira AN, Mcbride AJ, Scaini CJ, et al. Human toxocariasis: current advances in diagnostics, treatment, and interventions. Trends Parasitol. 2014; 30: 456-464.

85. Stull JW, Carr AP, Chomel BB, Berghaus RD, Hird DW. Small animal deworming protocols, client education, and veterinarian perception of zoonotic parasites in western Canada. Can Vet J. 2007; 48: 269-276.

86. Elsemore DA, Geng J, Cote J, Hanna R, Lucio-Forster A, Bowman DD. Enzyme-linked immunosorbent assays for coproantigen detection of Ancylostoma caninum and *Toxocara canis* in dogs and *Toxocara cati* in cats. J Vet Diagn Invest. 2017; 1: 1040638717706098.

87. Martínez M, García H, Figuera L, González V, Lamas F, López K, et al. Seroprevalence and risk factors of toxocariasis in preschool children in Aragua state, Venezuela. Trans R Soc Trop Med Hyg. 2015; 109: 579-588.

88. Lötsch F, Obermüller M, Mischlinger J, Mombo-Ngoma G, Groger M, Adegnika AA, et al. Seroprevalence of *Toxocara* spp. in a rural population in Central African Gabon. Parasitol Int. 2016; 65: 632-634.

89. Gao X, Wang H, Li J, Qin H, Xiao J. Influence of land use and meteorological factors on the spatial distribution of *Toxocara canis* and *Toxocara cati* eggs in soil in urban areas. Vet Parasitol. 2017; 233: 80-85.

90. Santarém VA, Sartor IF, Bergamo FM. [Contamination, by *Toxocara* spp eggs, in public parks and squares in Botucatu, São Paulo, Brazil]. Rev Soc Bras Med Trop. 1998; 31: 529-532.

91. Capuano DM, Rocha Gde M. Environmental contamination by *Toxocara* sp. eggs in Ribeirão Preto, São Paulo State, Brazil. Rev Inst Med Trop Sao Paulo. 2005; 47: 223-226.

92. Ferreira FP, Ferreira DRCF, Martins TA, Constantino C, Sbruzzi PAK, et al. Frequency of gastrointestinal parasites in dogs and cats of Londrina, PR, focusing on public health. Semina: Ciências Agrárias, Londrina, 2013, 34: 3851-3858.

93. Lavallén C, Brignani B, Riesgo K, Rojas A, Colace G, et al. Enteroparasitoses and Toxocarosis Affecting Children from Mar del Plata City, Argentina. Ecohealth. 2017; 14: 219-233.

94. Rostami A, Ebrahimi M, Mehravar S, Fallah Omrani V, Fallahi S, Behniafar H. Contamination of commonly consumed raw vegetables with soil transmitted helminth eggs in Mazandaran province, northern Iran. Int J Food Microbiol. 2016; 225: 54-58.

95. Borecka A. [The spread of nematodes from *Toxocara* genus in the world]. Wiad Parazytol. 2010; 56: 117-124.

96. de Castro JM, dos Santos SV, Monteiro NA. [Contamination of public gardens along seafront of Praia Grande City, São Paulo, Brazil, by eggs of Ancylostoma and *Toxocara* in dogs feces]. Rev Soc Bras Med Trop. 2005; 38: 199-201.

97. Campos-Da-Silva DR, Da Paz JS, Fortunato VR, Beltrame MA, Valli LC, Pereira FE, et al. Contamination of public gardens along seafront of Praia Grande City, São Paulo, Brazil, by eggs of Ancylostoma and *Toxocara* in dogs feces. Rev Soc Bras Med Trop. 2005; 38: 1-10.

98. Doi R, Itoh M, Chakhatrakan S, Uga S. Epidemiological Investigation of Parasitic Infection of Schoolchildren from Six Elementary Schools in Sakon Nakhon Province. Thailand. Kobe J Med Sci. 2017; 62: 120-128.

99. Gawor J, Borecka A. Quantifying the risk of zoonotic geohelminth infections for rural household inhabitants in Central Poland. Ann Agric Environ Med. 2017; 24: 44-48.

100. Szwabe K, Blaszkowska J. Stray dogs and cats as potential sources of soil contamination with zoonotic parasites. Ann Agric Environ Med. 2017; 24: 39-43.

101. O'Lorcain P. Epidemiology of *Toxocara* spp. in stray dogs and cats in Dublin, Ireland. J Helminthol. 1994; 68: 331-336.

102. Nagakura K, Tachibana H, Kaneda Y, Kato Y. Toxocariasis possibly caused by ingesting raw chicken. J Infect Dis. 1989; 160: 735-736.

103. Taira K, Saitoh Y, Okada N, Sugiyama H, Kapel CM. Tolerance to low temperatures of *Toxocara cati* larvae in chicken muscle tissue. Vet Parasitol. 2012; 189: 383-386.

104. Keegan JD, Holland CV. A comparison of *Toxocara canis* embryonation under controlled conditions in soil and hair. J Helminthol. 2013; 87: 78-84.

105. Pautova EA, Shchuchinova LD, Dovgalev AS. [The development and survival of toxocara canis eggs in the natural climatic conditions of gorno-altaisk]. Med Parazitol (Mosk). 2015; 42-44.

106. Oliveira CA, Germano PM. Presence of intestinal parasites in vegetables sold in the metropolitan region of São Paulo, SP, Brazil. I-Search of helminths. Rev Saude Publica. 1992; 26: 283-289.

107. Oudni-M'rad M, Chaâbane-Banaoues R, M'rad S, Trifa F, Mezhoud H, Babba H, et al. Gastrointestinal parasites of canids, a latent risk to human health in Tunisia. Parasit Vectors. 2017; 10: 280.

108. Chieffi PP, Müller EE. Prevalence of parasitic diseases by *Toxocara canis* in dogs, and the finding of eggs of *Toxocara* species in the soil of public places in the urban area of Londrina, State of Paraná, Brazil. Rev Saude Publica. 1976; 10: 367-372.

109. Oliveira-Sequeira TC, Amarante AF, Ferrari TB, Nunes LC. Prevalence of intestinal parasites in dogs from São Paulo State, Brazil. Vet Parasitol. 2002; 103: 19-27.

110. Blaszkowska J, Wojcik A, Kurnatowski P, Szwabe K. Geohelminth egg contamination of children's play areas in the city of Lodz (Poland). Vet Parasitol. 2013; 192: 228-233.

111. Błaszkowska J, Góralska K, Wójcik A, Kurnatowski P, Szwabe K. Presence of *Toxocara* spp. eggs in children's recreation areas with varying degrees of access for animals. Ann Agric Environ Med. 2015; 22: 23-27.

112. Schoenardie ER, Scaini CJ, Pepe MS, Borsuk S, de Avila LF, Villela M, et al. Vertical transmission of *Toxocara canis* in successive generations of mice. Rev Bras Parasitol Vet. 2013; 22: 623-626.

113. Choi D, Lim JH, Choi DC, Lee KS, Paik SW, Kim SH, et al. Transmission of *Toxocara canis* via ingestion of raw cow liver: a cross-sectional study in healthy adults. Korean J Parasitol. 2012; 50: 23-27.

114. Noh Y, Hong ST, Yun JY, Park HK, Oh JH, Kim YE, et al. Meningitis by *Toxocara canis* after ingestion of raw ostrich liver. J Korean Med Sci. 2012; 27: 1105-1108.

115. Muradian V, Gennari SM, Glickman LT, Pinheiro SR. Epidemiological aspects of Visceral Larva Migrans in children living at São Remo Community, São Paulo (SP), Brazil. Vet Parasitol. 2005; 134: 93-97.

116. Panova OA, Glamazdin IG, Spiridonov SE. [Animal toxocariasis in a megalopolis: epidemic aspects]. Med Parazitol (Mosk). 2015; 39-41.

117. Campos Júnior D, Elefant GR, de Melo e Silva EO, Gandolfi L, Jacob CM, Tofeti A, et al. [Frequency of seropositivity to *Toxocara canis* in children of different socioeconomic strata]. Rev Soc Bras Med Trop. 2003; 36: 509-513.

118. Fu CJ, Chuang TW, Lin HS, Wu CH, Liu YC, Langinlur MK, et al. Seroepidemiology of *Toxocara canis* infection among primary schoolchildren in the capital area of the Republic of the Marshall Islands. BMC Infect Dis. 2014; 14: 261.

119. Wright I, Stafford K, Coles G. The prevalence of intestinal nematodes in cats and dogs from Lancashire, north-west England. J Small Anim Pract. 2016; 57: 393-395.

120. Matsumura K, Endo R. Seroepidemiological study on toxocaral infection in man by enzyme-linked immunosorbent assay. J Hyg (Lond). 1983; 90: 61-65.

121. Ljungström I, van Knapen F. An epidemiological and serological study of toxocara infection in Sweden. Scand J Infect Dis. 1989; 21: 87-93.

122. Roldán WH, Cavero YA, Espinoza YA, Jiménez S, Gutiérrez CA. Human toxocariasis: a seroepidemiological survey in the Amazonian city of Yurimaguas, Peru. Rev Inst Med Trop Sao Paulo. 2010; 52: 37-42.

123. Agudelo C, Villareal E, Cáceres E, López C, Eljach J, Ramírez N, et al. Human and dogs *Toxocara canis* infection in a poor neighborhood in Bogota. Mem Inst Oswaldo Cruz. 1990; 85: 75-78.

124. Thompson DE, Bundy DA, Cooper ES, Schantz PM. Epidemiological characteristics of *Toxocara canis* zoonotic infection of children in a Caribbean community. Bull World Health Organ. 1986; 64: 283-290.

125. Barriga OO. A critical look at the importance, prevalence and control of toxocariasis and the possibilities of immunological control. Vet Parasitol. 1988; 29: 195-234.

126. Erickson LD, Gale SD, Berrett A, Brown BL, Hedges DW. Association between toxocariasis and cognitive function in young to middle-aged adults. Folia Parasitol (Praha). 2015; 62: 48.

127. Roldán WH, Elefant GR, Ferreira AW. Immunoglobulin M antibodies are not specific for serodiagnosis of human toxocariasis. Parasite Immunol. 2017; 39.

128. Chieffi PP, Ueda M, Camargo ED, de Souza AM, Guedes ML, Gerbi LJ, et al. Visceral larva migrans: a seroepidemiological survey in five municipalities of São Paulo state, Brazil. Rev Inst Med Trop Sao Paulo. 1990; 32: 204-210.

129. Alderete JM, Jacob CM, Pastorino AC, Elefant GR, Castro AP, Fomin AB, et al. Prevalence of *Toxocara* infection in schoolchildren from the Butantã region, São Paulo, Brazil. Mem Inst Oswaldo Cruz. 2003; 98: 593-597.

130. Virginia P, Nagakura K, Ferreira O, Tateno S. Serologic evidence of toxocariasis in northeast Brazil. Jpn J Med Sci Biol. 1991; 44: 1-6.

131. De Andrade Lima Coêlho R1, De Carvalho LB Jr, Perez EP, Araki K, Takeuchi T, Ito A, et al. Prevalence of toxocariasis in northeastern Brazil based on serology using recombinant *Toxocara canis* antigen. Am J Trop Med Hyg. 2005; 72: 103-107.

132. Teixeira CR, Chieffi PP, Lescano SA, de Melo Silva EO, Fux B, Cury MC. Frequency and risk factors for toxocariasis in children from a pediatric outpatient center in southeastern Brazil. Rev Inst Med Trop Sao Paulo. 2006; 48: 251-255.

133. Grama DF, Lescano SZ, Pereira Mota KC, dos Anjos Pultz B, Miranda JS, Silva Segundo GR, et al. Seroprevalence of *Toxocara* spp. in children with atopy. Trans R Soc Trop Med Hyg. 2014; 108: 797-803.

134. Guilherme EV, Marchioro AA, Araujo SM, Falavigna DL, Adami C, Falavigna-Guilherme G, et al. Toxocariasis in children attending a Public Health Service Pneumology Unit in Parana State, Brazil. Rev Inst Med Trop Sao Paulo. 2013; 55.

135. Manini MP, Marchioro AA, Colli CM, Nishi L, Falavigna-Guilherme AL. Association between contamination of public squares and seropositivity for *Toxocara* spp. in children. Vet Parasitol. 2012; 188: 48-52.

136. Pereira LC1, Elefant GR, Nóbrega YM, Vital T, Nitz N, Gandolfi L, et al. *Toxocara* spp. seroprevalence in pregnant women in Brasília, Brazil. Rev Soc Bras Med Trop. 2016; 49: 641-643.

137. Cassenote AJ, Lima AR, Pinto Neto JM, Rubinsky-Elefant G. Seroprevalence and modifiable risk factors for *Toxocara* spp. in Brazilian schoolchildren. PLoS Negl Trop Dis. 2014; 8: e2830.

138. Foccacia R. Infectology Treaty. 109 Chapter, 5th edn. Edn. Atheneu, 2015; 2: 2113-2117.

139. Santos PC, Lehmann LM, Lorenzi C, Hirsch C, Telmo PL, Mattos GT, et al. The Seropositivity of *Toxocara* spp. Antibodies in Pregnant Women Attented at the University Hospital in Southern Brazil and the Factors Associated with Infection. PLoS One. 2015; 10: e0131058.

140. Mattos GT, Santos PC, Telmo PL, Berne ME, Scaini CJ. Human Toxocariasis: Prevalence and Factors Associated with Biosafety in Research Laboratories. Am J Trop Med Hyg. 2016; 95: 1428-1431.

141. Sperotto RL, Kremer FS, Aires Berne ME, Costa de Avila LF, da Silva Pinto L, Monteiro KM, et al. Proteomic analysis of *Toxocara canis* excretory and secretory (TES) proteins. Mol Biochem Parasitol. 2017; 211: 39-47.

142. Yamamoto T, Miyazaki T, Kurashima Y, Ohata K, Okawa M, Tanaka S, et al. Solitary Hepatic Eosinophilic Granuloma Accompanied by Eosinophilia Without Parasitosis: Report of a Case. Int Surg. 2015; 100: 1011-1017.

143. Kang EJ, Choi YJ, Kim JS, Lee BH, Kang KW, Kim HJ, et al. Bladder and liver involvement of visceral larva migrans may mimic malignancy. Cancer Res Treat. 2014; 46: 419-424.

144. Mukund A, Arora A, Patidar Y, Mangla V, Bihari C, Rastogi A, et al. Eosinophilic abscesses: a new facet of hepatic visceral larva migrans. Abdom Imaging. 2013; 38: 774-777.

145. Rubinsky-Elefant G, Hirata CE, Yamamoto JH, Ferreira MU. Human toxocariasis: diagnosis, worldwide seroprevalences and clinical

expression of the systemic and ocular forms. Ann Trop Med Parasitol. 2010; 104: 3-23.

146. Cerruto MA, D'Elia C, Artibani W. A case of eosinophilic cystitis in patients with abdominal pain, dysuria, genital skin hyperemia and slight toxocariasis. Arch Ital Urol Androl. 2013; 85: 99-100.

147. Nicoletti A. Toxocariasis. Handb Clin Neurol. 2013; 114: 217-228.

148. Gawor J, Borecka A, Zarnowska H, Marczyńska M, Dobosz S. Environmental and personal risk factors for toxocariasis in children with diagnosed disease in urban and rural areas of central Poland. Vet Parasitol. 2008; 155: 217-222.

149. Silva MB, Amor AL, Santos LN, Galvão AA, Oviedo V AY, Silva ES, et al. Data on prevalence and risk factors associated with *Toxocara* spp infection, atopy and asthma development in Northeast Brazilian school children. Data Brief. 2016; 9: 425-428.

150. Lemaire A, Trouillier S, Samou F, Delevaux I, Aumaître O. [Visceral larva migrans with cardiac manifestation: a case report and literature review]. Rev Med Interne. 2014; 35: 831-837.

151. Lim JH. Toxocariasis of the liver: visceral larva migrans. Abdom Imaging. 2008; 33: 151-156.

152. Koumar Y, Lechiche C, Sotto A, Lachaud L. Invasive toxocariasis with hepatic lesions. Med Mal Infect. 2017; 47: 71-72.

153. Kaplan KJ, Goodman ZD, Ishak KG. Eosinophilic granuloma of the liver: a characteristic lesion with relationship to visceral larva migrans. Am J Surg Pathol. 2001; 25: 1316-1321.

154. Enko K, Tada T, Ohgo KO, Nagase S, Nakamura K, Ohta K, et al. Fulminant eosinophilic myocarditis associated with visceral larva migrans caused by *Toxocara canis* infection. Circ J. 2009; 73: 1344-1348.

155. Kuenzli E, Neumayr A, Chaney M, Blum J. Toxocariasis-associated cardiac diseases--A systematic review of the literature. Acta Trop. 2016; 154: 107-120.

156. Park EJ, Song JY, Choi MJ, Jeon JH, Choi JY, Yang TU, et al. Pulmonary toxocariasis mimicking invasive aspergillosis in a patient with ulcerative colitis. Korean J Parasitol. 2014; 52: 425-428.

157. Takakura A, Harada S, Katono K, Igawa S, Katagiri M, Yanase N, et al. A Case Strongly Suspected of Being Pulmonary Toxocariasis Showing Multiple Pulmonary Nodules with a Disappearing and Reappearing Halo Sign. Kansenshogaku Zasshi. 2015; 89: 265-269.

158. Jorge D, Strady C, Guy B, Deslée G, Lebargy F, Dury S. [Multiple pulmonary opacities revealing toxocariasis]. Rev Pneumol Clin. 2016; 72: 273-276.

159. Park KH, Kim YS, Kim SK, Choi NC, Kwon OY, Lim B, et al. *Toxocara canis*-Associated Myelitis with Eosinophilic Pneumonia. Exp Neurobiol. 2016; 25: 139-142.

160. Abir B, Malek M, Ridha M. Toxocariasis of the central nervous system: With report of two cases. Clin Neurol Neurosurg. 2017; 154: 94-97.

161. Sick C, Hennerici MG. Expect the unexpected: a case of isolated eosinophilic meningitis in toxocariasis. Case Rep Neurol. 2014; 6: 259-263.

162. Liu Y, Zhang Q, Li J, Ji X, Xu Y, Zhao P. Clinical Characteristics of Pediatric Patients with Ocular Toxocariasis in China. Ophthalmologica. 2016; 235: 97-105.

163. Kwon JW, Sim Y, Jee D. Association between intermediate uveitis and toxocariasis in the Korean population. Medicine (Baltimore). 2017; 96: e5829.

164. Pak KY, Park SW, Byon IS, Lee JE. Ocular toxocariasis presenting as bilateral scleritis with suspect retinal granuloma in the nerve fiber layer: a case report. BMC Infect Dis. 2016; 16: 426.

165. Bahnea RG, Cârdei E, Luca MC, Cojocaru I, Rîpa C, Luca M. Cutaneous manifestations on toxocariasis cases hospitalized in the Pediatric Diseases Clinic of Iasi, between 2005-2008. Rev Med Chir Soc Med Nat Lasi. 2009; 113: 428-431.

166. Kayes SG. Human toxocariasis and the visceral larva migrans syndrome: correlative immunopathology. Chem Immunol. 1997; 66: 99-124.

167. Vargas C, Torres P, Jercic MI, Lobos M, Oyarce A, Miranda JC, et al. Frequency of anti-*Toxocara* spp. antibodies in individuals attended by the centro de salud familiar and environmental contamination with *Toxocara canis* eggs in dog feces, in the Coastal Niebla town, Chile. Rev Inst Med Trop Sao Paulo. 2016; 58: 62.

168. Ko KD, Lee JJ, Kim KK, Suh HS, Hwang IC, Choi SJ. Hepatic Visceral Larva Migrans Due to *Toxocara* Canis in a 72-Year-Old Man. Southeast Asian J Trop Med Public Health. 2015; 46: 181-183.

169. Mazur-Melewska K, Jończyk-Potoczna K, Kemnitz P, Mania A, Figlerowicz M, Służewski W. Pulmonary presentation of *Toxocara* sp. infection in children. Pneumonol Alergol Pol. 2015; 83: 250-255.

170. Jee D, Kim KS, Lee WK, Kim W, Jeon S. Clinical Features of Ocular Toxocariasis in Adult Korean Patients. Ocul Immunol Inflamm. 2016; 24: 207-216.

171. Boldiš V, Ondriska F, Špitalská E, Reiterová K. Immunodiagnostic approaches for the detection of human toxocarosis. Exp Parasitol. 2015; 159: 252-258.

172. Mazur-Melewska K, Figlerowicz M, Cwalinska A, Mikos H, Jonczyk-Potoczna K, Lewandowska-Stachowiak M, et al. Production of interleukins 4 and 10 in children with hepatic involvement in the course of *Toxocara* spp. infection. Parasite Immunol. 2016; 38: 101-107.

173. Nagy D, Bede O, Danka J, Szénási Z, Sipka S. Analysis of serum cytokine levels in children with chronic cough associated with *Toxocara canis* infection. Parasite Immunol. 2012; 34: 581-588.

174. Ahn SJ, Woo SJ, Jin Y, Chang YS, Kim TW, Ahn J, et al. Clinical features and course of ocular toxocariasis in adults. PLoS Negl Trop Dis. 2014; 8: e2938.

175. Musso C, Castelo JS, Tsanaclis AM, Pereira FE. Prevalence of *Toxocara*-induced liver granulomas, detected by immunohistochemistry, in a series of autopsies at a Children's Reference Hospital in Vitoria, ES, Brazil. Virchows Arch. 2007; 450: 411-417.

176. Zibaei M, Uga S. Modified method to enhanced recovery of *Toxocara cati* larvae for the purposes of diagnostic and therapeutic. Exp Parasitol. 2016; 169: 107-110.

177. Merdin A, Ogur E, Çiçek Kolak Ç, Avcı Merdin F. A Rare Cause of Hypereosinophilia: A Case Report. Turkiye Parazitol Derg. 2016; 40: 114-116.

178. Mazur-Melewska K, Jonczyk K, Modlinska-Cwalinska A, Figlerowicz M, Sluzewski W. Visceral larva migrans syndrome: analysis of serum cytokine levels in children with hepatic lesions confirmed in radiological findings. Parasite Immunol. 2014; 36: 668-673.

179. Jang EY, Choi MS, Gwak GY, Koh KC, Paik SW, Lee JH, et al. Enhanced resolution of eosinophilic liver abscess associated with toxocariasis by albendazole treatment. Korean J Gastroenterol. 2015; 65: 222-228.

180. Zibaei M, Sadjjadi SM, Jahadi-Hosseini SH. *Toxocara cati* larvae in the eye of a child: a case report. Asian Pac J Trop Biomed. 2014; 4: 53-55.

181. Fenoy S, Cuéllar C, Aguila C, Guillén JL. Persistence of immune response in human toxocariasis as measured by ELISA. Int J Parasitol. 1992; 22: 1037-1038.

182. Bae KW, Ahn SJ, Park KH, Woo SJ. Diagnostic Value of the Serum Anti-*Toxocara* IgG Titer for Ocular Toxocariasis in Patients with Uveitis at a Tertiary Hospital in Korea. Korean J Ophthalmol. 2016; 30: 258-264.

183. Wang ZJ, Zhou M, Cao WJ, Ji J, Bi YW, Huang X, et al. Evaluation of the Goldmann-Witmer coefficient in the immunological diagnosis of ocular toxocariasis. Acta Trop. 2016; 158: 20-23.

184. Zhang HF, Hua HY, Wang W. Pediatric ocular toxocariasis in Jiangsu province, Eastern china. Southeast Asian J Trop Med Public Health. 2015; 46: 8-14.

185. Watthanakulpanich D, Smith HV, Hobbs G, Whalley AJ, Billington D. Application of *Toxocara canis* excretory-secretory antigens and IgG subclass antibodies (IgG1-4) in serodiagnostic assays of human toxocariasis. Acta Trop. 2008; 106: 90-95.

186. Zahabiun F, Sadjjadi SM, Yunus MH, Rahumatullah A, Moghaddam MH, Saidin S, et al. Production of *Toxocara cati* TES-120 Recombinant Antigen and Comparison with its *T. canis* Homolog for Serodiagnosis of Toxocariasis. Am J Trop Med Hyg. 2015; 93: 319-325.

187. Camargo ED, Nakamura PM, Vaz AJ, da Silva MV, Chieffi PP, de Melo EO. Standardization of dot-ELISA for the serological diagnosis of toxocariasis and comparison of the assay with ELISA. Rev Inst Med Trop Sao Paulo. 1992; 34: 55-60.

188. Mendonça LR, Veiga RV, Dattoli VC, Figueiredo CA, Fiaccone R, Santos J, et al. *Toxocara* seropositivity, atopy and wheezing in children living in poor neighbourhoods in urban Latin American. PLoS Negl Trop Dis. 2012; 6: e1886.

189. Noordin R, Smith HV, Mohamad S, Maizels RM, Fong MY. Comparison of IgG-ELISA and IgG4-ELISA for *Toxocara* serodiagnosis. Acta Trop. 2005; 93: 57-62.

190. Rudzinska M, Kowalewska B, Sikorska K. Clinical usefulness of Western blotting and ELISA avidity for the diagnosis of human toxocariasis. Parasite Immunol. 2017; 39.

191. Despreaux R, Fardeau C, Touhami S, Brasnu E, Champion E, Paris L, et al. Ocular Toxocariasis: Clinical Features and Long-term Visual Outcomes in Adult Patients. Am J Ophthalmol. 2016; 166: 162-168.

192. Ural S, Özer B, Gelal F, Dirim Erdogan D, Sezak N, Balik R, et al. Transverse myelitis associated with toxocariasis and the importance of locally produced antibodies for diagnosis. Mikrobiyol Bul. 2016; 50: 478-483.

193. Magnaval JF, Berry A, Fabre R, Morassin B. Eosinophil cationic protein as a possible marker of active human *Toxocara* infection. Allergy. 2001; 56: 1096-1099.

194. Schantz PM, Glickman LT. [Ascarids of cats and dogs: a public health and veterinary medicine problem]. Bol Oficina Sanit Panam. 1983; 94: 571-586.

195. Momeni T, Mahami-Oskouei M, Fallah E, Safaiyan A, Mahami-Oskouei L. Latent and Asymptomatic *Toxocara* Infection among Young Population in Northwest Iran: The Necessity of Informing People as a Potential Health Risk. Scientifica (Cairo). 2016; 2016: 3562056.

196. Finsterer J, Auer H. Neurotoxocarosis. Rev Inst Med Trop Sao Paulo. 2007; 49: 279-287.

197. Woodhall DM, Fiore AE. Toxocariasis: A Review for Pediatricians. J Pediatric Infect Dis Soc. 2014; 3: 154-159.

198. Liu J, Li S, Deng G, Yang W, Chen W, Lu H. Ultrasound biomicroscopic imaging in paediatric ocular toxocariasis. Br J Ophthalmol. 2017.

199. Kagialis-Girard S, Mialou V, Ffrench M, Dupuis-Girod S, Pages MP, Bertrand Y. Thrombocytosis and toxocariasis: report of two pediatric cases. Pediatr Blood Cancer. 2005; 44: 190-192.

200. Yoon Dy, Woo SJ. Intravitreal Administration of Ranibizumab and Bevacizumab for Choroid Neovascularization Secondary to Ocular Toxocariasis: A Case Report. Ocul Immunol Inflamm. 2016; 24: 1-3.

201. Deuter CM, Garweg JG, Pleyer U, Schönherr U, Thurau S. [Ocular toxoplasmosis and toxocariasis in childhood]. Klin Monbl Augenheilkd. 2007; 224: 483-487.

202. Kollipara R, Peranteau AJ, Nawas ZY, Tong Y, Woc-Colburn L, Yan AC, et al. Emerging infectious diseases with cutaneous manifestations: fungal, helminthic, protozoan and ectoparasitic infections. J Am Acad Dermatol. 2016; 75: 19-30.

203. Ozlati M, Spotin A, Shahbazi A, Mahami-Oskouei M, Hazratian T, Adibpor M, et al. Genetic variability and discrimination of low doses of *Toxocara* spp. from public areas soil inferred by loop-mediated isothermal amplification assay as a field-friendly molecular tool. Vet World. 2016; 9: 1471-1477.

204. Thomas D, Jeyathilakan N. Detection of *Toxocara* eggs in contaminated soil from various public places of Chennai city and detailed correlation with literature. J Parasit Dis. 2014; 38: 174-180.

205. Otero D, Alho AM, Nijsse R, Roelfsema J, Overgaauw P, Madeira CL. Environmental contamination with *Toxocara* spp. eggs in public parks and playground sandpits of Greater Lisbon, Portugal. J Infect Public Health. 2017; 22: S1876-0341(17)30134-X.

206. Gotkowska-Płachta A, Korzeniewska E. Microbial evaluation of sandboxes located in urban area. Ecotoxicol Environ Saf. 2015; 113: 64-71.

207. Matos Fialho PM, Correa CR, Lescano SZ. Seroprevalence of Toxocariasis In Children With Urticaria: A Population-Based Study. J Trop Pediatr. 2017.

208. Centers for Disease Control and Prevention (CDC). Ocular toxocariasis--United States, 2009-2010. MMWR Morb Mortal Wkly Rep. 2011; 60: 734-736.

209. Woodhall D, Starr MC, Montgomery SP, Jones JL, Lum F, Read RW, et al. Ocular toxocariasis: epidemiologic, anatomic, and therapeutic variations based on a survey of ophthalmic subspecialists. Ophthalmology. 2012; 119: 1211-1217.

210. Alvarado-Esquivel C. Toxocariasis in waste pickers: a case control seroprevalence study. PLoS One. 2013; 8: e54897.

211. Anh NT, Thuy DT, Hoan DH, Hop NT, Dung DT. Levels of *Toxocara* infections in dogs and cats from urban Vietnam together with associated risk factors for transmission. J Helminthol. 2016; 90: 508-510.

212. Silva MB, Amor AL, Santos LN, Galvão AA, Oviedo V AY, Silva ES, et al. Data on prevalence and risk factors associated with *Toxocara* spp infection, atopy and asthma development in Northeast Brazilian school children. Data Brief. 2016; 9: 425-428.

213. Etewa SE, Abdel-Rahman SA, Abdel-AaL NF, Fathy GM, El-Shafey MA, Ewis AM. Geohelminths distribution as affected by soil properties, physicochemical factors and climate in Sharkyia governorate Egypt. J Parasit Dis. 2016; 40: 496-504.

214. Nijsse R, Mughini-Gras L, Wagenaar JA, Franssen F, Ploeger HW. Environmental contamination with *Toxocara* eggs: a quantitative approach to estimate the relative contributions of dogs, cats and

foxes, and to assess the efficacy of advised interventions in dogs. Parasit Vectors. 2015; 8: 397.

215. Moskvina TV, Bartkova AD, Ermolenko AV. Geohelminths eggs contamination of sandpits in Vladivostok, Russia. Asian Pac J Trop Med. 2016; 9: 1215-1217.

216. Öge H, Öge S, Özbakış G, Gürcan IS. Helminth Infections by Coprological Examination in Sheep-Dogs and Their Zoonotic Importance. Turkiye Parazitol Derg. 2017; 41: 22-27.

217. Papajová I, Juris P, Szabová E, Venglovský J, Sasáková N, Sefcíková H, et al. Decontamination by anaerobic stabilization of the environment contaminated with enteronematode eggs *Toxocara canis* and Ascaris suum. Bioresour Technol. 2008; 99: 4966-4971.

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