

Review Article

A Systematic Review of Toxocariasis: A Neglected but High-Prevalence Disease in Brazil

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Abstract. Toxocariasis is an anthrozoosis that occurs in all parts of the world. In particular, this disease can often be found in developing countries and in regions, where basic sanitation conditions are poor. However, industrialized countries have reported seroprevalence rates as high as 14.2% in humans. The definitive hosts of the disease are dogs and cats, whereas humans are a paratenic host. To determine the burden of toxocariasis in Brazil, we followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines to conduct a systematic review of the literature. Using keywords and applying the established criteria, we identified 160 publications and selected 22 articles for further analysis. The seroprevalence of toxocariasis in various regions of the country ranged from 4.2% to 65.4%. The highest prevalence was found in the northeast region, although the majority of the studies identified were from the southeast region. The findings suggest the importance of raising awareness among health professionals and public authorities about the fact that toxocariasis is a health problem.

INTRODUCTION

The term “toxocariasis” is used in medical practice to designate the human infection produced by the roundworms *Toxocara canis* and *Toxocara cati*. *Toxocara canis* is the nematode most frequently found in Canidae, which are accidental hosts of this roundworm. Other animal species, such as rats, birds, and humans, are accidental hosts and act as reservoirs for these parasites.¹

The infection of humans occurs by ingestion of eggs that are present in the soil via foods such as vegetables and by consumption of the meat and/or raw or undercooked viscera of chicken, ducks, or cattle infected with *T. canis* larvae.^{2–4} Once ingested, the eggs hatch in the intestinal lumen, and the larvae are then released into the circulatory system and settle in various organs and tissues, including the eye, brain, lungs, liver, and muscles.⁵ The host immune response involves both the innate and the adaptive systems. Th2 lymphocytes are specifically produced, including interleukins 4, 5, 10, and 13, and lecithins are released.⁶

The hygiene hypothesis implies that a helminth infection will decrease allergic reactions and diseases, including obesity, by interfering with the immune response.^{7–9} However, Maizels⁶ notes that this allergic modulation does not occur with the infections produced by *T. canis* in rats. One reason may be that these animals are not the definitive hosts of the parasite, so there may be another type of inflammatory modulation in this host. In any case, Fialho and Corrêa¹⁰ showed that asthmatic children infected with *Toxocara* have a higher body mass index than do asthmatic children not infected with the parasite. The association between asthma and toxocariasis has been noted by various articles published in several countries, although the studies were all based on cross-sectional designs. Even though these studies proposed valid hypotheses, a cross-sectional design is a substantial limitation for

determining a causal relationship in associations between factors (in this case, asthma and obesity) because no cause–effect correlation can be determined between variables if they are measured at the same time.¹¹

Human infections can cause serious clinical disease, with various levels of severity and possible chronicity. The diagnosis of toxocariasis is performed using an enzyme-linked immunosorbent assay (ELISA) specific for excretion–secretion antigens,¹² and the classic treatment is antihelminthic drugs.¹³

Toxocariasis has always been present but has had varying prevalence rates. A study conducted by Campos Júnior and Elefant¹⁴ showed a significant difference between the prevalence of seropositivity for *T. canis* among children from poor neighborhoods in Brasilia (21.8%) and children living in the wealthiest sectors of the city (3%). The prevalence in Brasilia can be compared with the reported prevalences of 37.9% in subtropical Argentina,¹⁵ 39% in the city of La Plata,¹⁶ 29.6% in Nigeria,¹⁷ 22% in western France,¹⁸ 30% in the outskirts of Caracas,¹⁹ and 27.2% in a school population in Trinidad.²⁰

Toxocariasis is an important but neglected tropical disease with a worldwide distribution and a high prevalence in both developing and developed countries. This disease is considered to be one of the most prevalent helminthiases in endemic areas in America. Human toxocariasis is also associated with important morbidities that are of public health concern and has been included on lists of neglected zoonoses.^{21–23} The present study is a systematic review that aims to understand how studies on the prevalence of toxocariasis in humans are being conducted in Brazil.

Based on the magnitude of its prevalence and its association with various diseases and clinical manifestations, toxocariasis is a relevant disease that should receive attention from public health systems. Accordingly, the specific aim of the present study is to verify, using a systematic review, the study populations and references of existing studies and the prevalence or incidence rates described in each of the investigations.

METHODS

Data and search strategy. Articles were selected from the following databases: PubMed (www.ncbi.nlm.nih.gov/PubMed/),

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Latin American and Caribbean Health Sciences Literature, Brazil (<http://www.bireme.br>), and Embase. The articles were published between January 2008 and October 2014. The descriptors and medical subject heading search terms all included “toxocariasis Brazil” in the bibliographic data, title field, and/or abstract and keywords. Articles were restricted to English and Portuguese.

Selection criteria. We used the following selection criteria: scientific articles originally published in national or international journals, studies with a date of publication between January 2008 and October 2014, studies on human beings, studies with no age limits on the study population, and studies reporting the prevalence or incidence of toxocariasis. As the main purpose was to determine the current prevalence of toxocariasis in several regions of Brazil, the selected studies could have been conducted in any Brazilian city, and the search period started with 2008.

Data extraction. The selection of articles and the data extraction were independently performed by two reviewers using a standardized instrument that collected the following information: study region, sample size, total number of seropositive individuals, study design, variables (risk factors, symptoms, morbidity, sociodemographic characteristics), main results, and study limitations. The data were compiled

in Microsoft Excel and were analyzed by comparing categorical variables.

RESULTS AND DISCUSSION

After the bibliographic search, we identified 160 publications. Among the 160 publications, 29 duplicates from two or more databases were discarded. After reading the titles and abstracts, 109 were excluded because they were not studies on human beings (they were experimental studies) or because there was no mention of the prevalence or incidence of toxocariasis. Therefore, a total of 22 complete articles were eligible for analysis. Figure 1 shows the flowchart of the study selection.

We selected 22 articles published between January 2008 and October 2014 that described the current prevalence of toxocariasis in various regions of the country; the values ranged from 4.2% to 65.4% (Table 1). The articles considered the epidemiological characterization of toxocariasis in Brazil over the last 6 years. Most studies used a cross-sectional design and presented the prevalence of the disease as a measure of frequency. One study described the incidence of toxocariasis, which was seven of 100 children in the year surveyed.³⁵

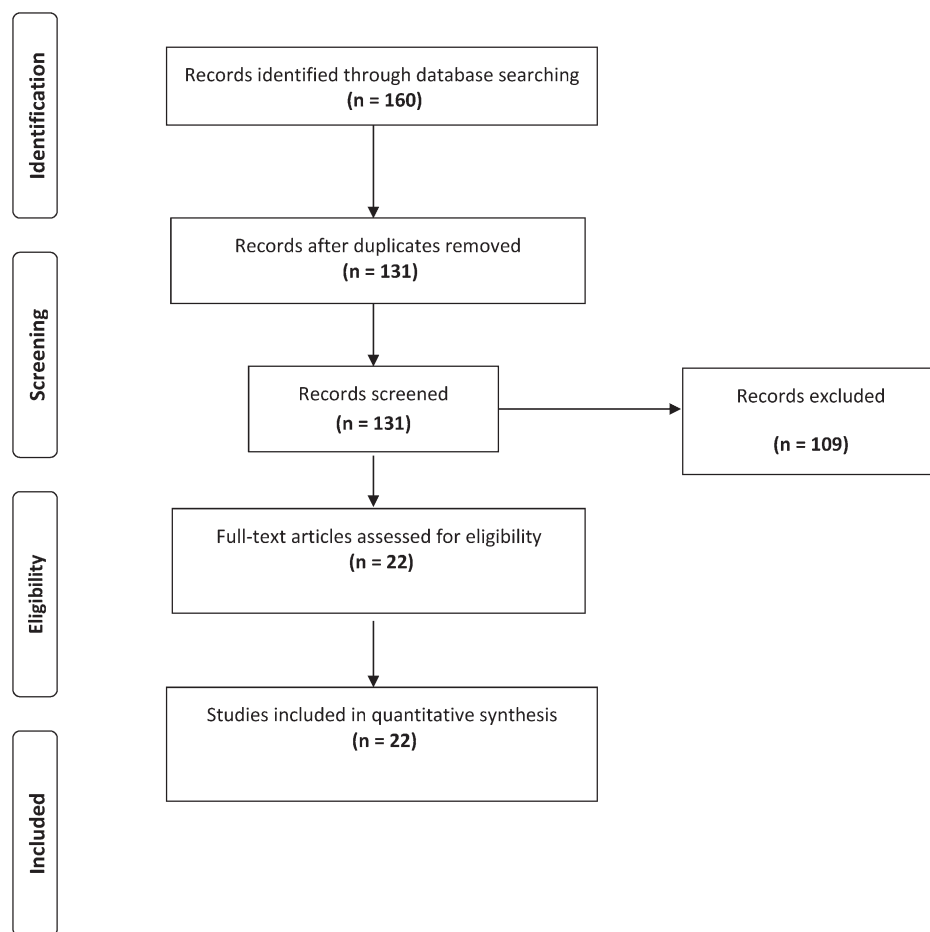


FIGURE 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses flowchart. (Adapted from Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group, 2009. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med* 6: e1000097.)

TABLE 1
Description of articles published from 2008 to 2014 that satisfied the search criteria

Article	Region	State	n	Total positives	Seroprevalence (%)	Main studied characteristics	Statistical evaluation
Marchioro and others, 2014 ²⁴	Southeast	Paraná	544	136	25.0	1–12 years; <i>Toxoplasma gondii</i> ; contact with dogs; contact with cats; eosinophilia; playing in the sand	Bivariate analysis; multiple logistic regression
Cassente and others, 2014 ²⁵	Southeast	São Paulo	252	39	15.5	1–12 years; sociodemographic characteristics; geophagy; onychophagia; hand washing habits; eosinophilia; intestinal parasites	Poisson multiple regression
Fialho and Corrêa, 2014 ¹⁰	Southeast	São Paulo	116	63	54.3	2–14 years; asthma; eosinophilia; height; weight; BMI	Descriptive analysis; Wilcoxon test for two samples
Negri and others, 2013 ²⁶	Southeast	São Paulo	253	22	8.7	19–65 years (blood donor); education; income; house location; dog; cat; garden; contact with soil; geophagy; onychophagia; raw meat consumption	Bivariate analysis; logistic regression
Guilherme and others, 2013 ²⁷	Southeast	Paraná	167	7	4.2	1–15 years; eosinophilia; allergies; rhinitis; asthma; bronchitis; domestic dog; domestic cat	Comparison of frequencies; ratio between the outer diameter of the sample and the optical density of the cutoff value
Schoenardie and others, 2013 ²⁸	Southeast	Rio Grande do Sul	427	216	50.6	1–12 years	chi-square test; Mante-Haenszel test; ORs
Prestes-Carneiro and others, 2013 ²⁹	Southeast	São Paulo	194	28	14.4	5–73 years; contact with dogs and cats; education; family income; eosinophilia; anemia; <i>T. gondii</i> ; <i>Taenia solium</i> metacystode	Chi-square test; Fisher's exact test; regression coefficients
Mamini and others, 2012 ³⁰	Southeast	Paraná	90	16	17.8	1–12 years; asthma; bronchitis; skin allergies; eosinophilia	Mean and standard deviation; relative and absolute frequencies; Fisher's exact test
Mattia and others, 2012 ³¹	Southeast	Paraná	353	130	36.8	0–12 years; recurrent wheezing; headache; fever; abdominal pain; eosinophilia; contact with dogs; contact with cats; geophagy; onychophagia	Bivariate analysis; logistic regression
Fragoso and others, 2011 ³²	Southeast	Espírito Santo	391	202	51.6	7 years; parasitological; eosinophilia; asthma history; skin allergy history; sociodemographic variables	Frequencies; 95% CIs
Marchioro and others, 2011 ³³	Southeast	Paraná	1,199	386	32.2	7 months to 12 years; eosinophilia	Descriptive analysis; chi-square test

(continued)

TABLE 1
Continued

Article	Region	State	<i>n</i>	Total positives	Seroprevalence (%)	Main studied characteristics	Statistical evaluation
Santarém and others, 2011 ³⁴	Southeast	São Paulo	126 + 126 Total = 252	12 + 16 Total = 28	9.5 + 12.7 Accumulated = 11.1	10 months to 15 years; eosinophilia; dog at home; domestic cat; onychophagia; social class (two-class comparison)	Mann-Whitney test; chi-square test or Fisher's exact test; multivariate logistic regression; ORs; 95% CIs
Correa and Bismarek, 2010 ³⁵	Southeast	São Paulo	100	28	28.0	6–14 years; toxocarasis incidence	Calculation of incidence and prevalence
Colli and others, 2010 ³⁶	Southeast	Paraná	376	194	51.6	1–12 years; eosinophilia; abdominal pain; headache; recurrent wheezing; parasitological (parasites not found); onychophagia; geophagy	Multiple logistic regression
Prestes-Carneiro and others, 2009 ³⁷	Southeast	São Paulo	182	25	13.7	4–84 years (≤ 15 vs. ≥ 15 years); risk factor (dog breeding, cat breeding, health conditions, level of education, clinical symptoms); anemia; leucopenia; neutropenia; lymphocytosis; monocytosis; eosinophilia	<i>t</i> -test for independent samples; chi-square test; Fisher's exact test; correlation; coefficient test; ORs; multiple logistic regression
Prestes-Carneiro and others, 2008 ³⁸	Southeast	São Paulo	79	17	21.5	≤ 15 vs. ≥ 15 years; eosinophilia; education; helminths; house with dogs and cats; anemia; health conditions; family income	<i>t</i> -test for independent samples; chi-square test; Fisher's exact test; correlation coefficients (<i>r</i>)
Mendonça and others, 2013 ³⁹	Northeast	Bahia	1,309	633	48.4	4–11 years; maternal education; going to school; paved street; domestic dog; domestic cat	Univariate analysis; multivariate logistic regression; ORs; 95% CIs
Mendonça and others, 2012 ⁴⁰	Northeast	Bahia	1,148	540	47.0	4–11 years (1.445); wheezing; allergies; parasitological findings; eosinophilia	Univariate analysis; multivariate logistic regression
Souza and others, 2011 ⁴¹	Northeast	Bahia	150 + 188	78 + 123	52.0 + 65.4	≤ 15 vs. ≥ 15 years; comparison of two population groups; contact with dogs; contact with cats; social class	Chi-square test; univariate and multivariate logistic regression
Dattoli and others, 2011 ⁴²	Northeast	Bahia	268	124	46.3	31–40 years (blood donor); eosinophilia; intestinal helminths (not found in samples); education	Univariate analysis; multivariate logistic regression; ORs; 95% CIs
Oliart-Guzmán and others, 2014 ⁴³	North	Amazonas	182 + 357	41 + 65	28.0 + 23.3	6 months to 59 months; socioeconomic status and demographic variables; wheezing; asthma; helminths; domestic dog; domestic cat	Variance analysis; chi-square test or Fisher's exact test
Rubinsky-Elefant and others, 2008 ⁴⁴	North	Amazonas	403	108	26.8	5–90 years; education of the family provider; presence of dogs; presence of cats; sector of residence; index of wealth; intestinal parasites	Prevalence rate; 95% CIs; chi-square test; Fisher's exact test; Mann-Whitney test; ORs; logistic regression

BMI = body mass index; CI = confidence interval; OR = odds ratio.

Geographical areas and socioeconomic class. Among the 22 articles analyzed, the most commonly studied Brazilian geographical regions were the southeast (41%), south (32%), northeast (18%), and north (9%). We did not find any study of the population in the midwest region.

In the northeast region, a study of 1,309 children aged 4–11 years was conducted in the city of Salvador, Bahia. The study investigated the possible association between seropositivity for *Toxocara*, atopy, and childhood wheezing in a population of children in poor areas of the city.⁴⁰ Also in the city of Salvador, another study, which examined 338 middle- and lower-class individuals, found a higher prevalence of toxocariasis among those of the lower class and those with greater contact with dogs and cats. The study also showed that being in the lower class was associated with a higher risk of infection with *T. canis*. This association may be related to the lack of knowledge of the population in relation to forms of infection, as well as to contact with dogs and cats that have not been dewormed.⁴¹

Another study, conducted by Santarém and others in 2011 in the municipality of Presidente Prudente, São Paulo, also examined the association between social class and seropositivity for *Toxocara*. The results showed that being in the upper middle class was a protective factor both for the total population and for subgroups (middle class and lower class).³⁴

Study population. The age of the subjects who participated in the studies ranged from 6 months to 90 years; however, the majority of the studies were conducted in children up to 15 years of age (68%) (Table 1).

The studies assessed in this review included sample sizes that ranged from 79 to 1,309 subjects, with 55% of the studies including 250–500 individuals (Table 1).

Three studies described the calculation of the sample size but did not describe their method of random sampling. In 86% of the studies, the authors relied on nonrandomized sampling.

Seroprevalence. The 22 studies analyzed in this review included 8,980 individuals who were evaluated for the presence of toxocariasis in four out of five Brazilian regions.

Due to the methodology used in the studies, the overall prevalence of toxocariasis in Brazil could not be calculated. However, most of the studies showed prevalence rates greater than 20%. Additionally, most studies evaluated the association of toxocariasis with other clinical manifestations.

The seroprevalence of the disease ranged from 4.2% to 65.4%. In 45% of the studies, the prevalence was higher than 50%. The highest prevalences were found in the northeast region (Table 1).

In the south region of the country, a study was conducted among 1,199 children aged 7 months to 12 years. The children resided in the urban areas of nine municipalities in the northwest region of Parana and were receiving assistance from the Unified Health System. The authors found a prevalence of 32.2%.³³ In contradiction to other studies,^{45–50} the majority of the children (80.4%) showed no eosinophilia.

In regard to the association between toxocariasis and other variables, 36% of the studies described a relationship with asthma or wheezing.^{10,27,30–32,36,40} In all of these studies, a higher proportion of patients with asthma was found among those infected with *Toxocara*, which lends this infection greater relevance in terms of public health.

The majority of studies (95.4%) described the diagnostic method for the detection of toxocariasis, which was

ELISA.^{10,24–29,31–34,36–44} One study did not describe the diagnostic methodology applied.³⁵ As *T. canis* and *T. cati* cannot be distinguished serologically, we identified the study population as having toxocariasis.

Although the Centers for Disease Control and Prevention in the United States acknowledges that toxocariasis is one of five neglected parasitic diseases for which there should be investment in diagnostic and therapeutic methods,^{21,23,51} the disease has not been widely recognized as a public health concern.

Toxocara canis infection is known to be associated with clinical polymorphism that varies from asymptomatic infection to asthmatic bronchitis and meningoencephalitis. Therefore, health professionals and the public health system should be aware that toxocariasis is a health problem. The present study provides relevant information for reflection on and review of public policies regarding toxocariasis.

The current burden and prevalence of disease due to toxocariasis in Brazil are largely unknown. We conducted this review to determine both the prevalence of toxocariasis and the amount of available data measuring the burden of toxocariasis in Brazil and to identify areas needing future research. Another salient point made by this review is that preventive efforts, such as prevention of soil contamination by dog and cat feces in public areas, hand washing after soil contact, and preventive anthelmintic treatment of puppies and kittens, can help to minimize exposure to *Toxocara* spp. and control potential morbidity associated with *Toxocara* infection.^{21,52}

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