Toxocariasis: America’s Most Common Neglected Infection of Poverty and a Helminthiasis of Global Importance?

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New information indicates that toxocariasis is the most common human parasitic worm infection in the United States, affecting millions of Americans living in poverty. The infection is also highly prevalent in many developing countries and its global importance may be greatly underestimated.

Toxocariasis results from zoonotic transmission of the roundworms, Toxocara canis and T. cati from dogs and cats, respectively. Infection occurs when humans accidentally ingest the microscopic, oval and thick-shelled-embryonated eggs (shed in dog and cat feces) containing Toxocara larvae by hand-to-mouth contact. Children are particularly prone to infection because they are exposed to the eggs on sandboxes and playgrounds contaminated with dog and cat feces [1,2]. After ingestion of the eggs, the released larvae penetrate the intestine and migrate through the liver, lungs, and central nervous system (Figure 1). The resulting host inflammatory response ultimately overwhelms and either kills the migrating larvae or forces them into a state of arrested development, but not before they cause both mechanical and immunopathological damage to the issues (Figure 2).

There are two “classical” clinical syndromes resulting from infection [1,2]. Visceral larva migrans occurs most commonly in young children and results in hepatitis and pneumonitis as the larvae migrate through the liver and lungs, respectively. The full clinical presentation of toxocariasis includes hepatomegaly and pulmonary infiltrates or nodules accompanied by cough, wheezing, eosinophilia, lymphadenopathy, and fever. Larval entry into the central nervous system can also result in meningoencephalitis and cerebritis manifesting as seizures [3,4]. Ocular larva migrans occurs more frequently in older children and adolescents and may result from the migration of even a single larva in the eye. The resulting inflammation presents clinically as either a granuloma or a granulomatous larval track in the retina or as a condition of the vitreous that resembles endophthalmitis [5,6]. Neither visceral larva migrans nor ocular larva migrans are considered common conditions, although the incidence of the former has not been determined and it has been estimated at just under 1 per 10,000 annually for the ocular form [6]. Far more common is non-classic, or covert toxocariasis, which may manifest with only some of the clinical features found in visceral larva migrans, especially wheezing, pulmonary infiltrates, and eosinophilia [2]. Because these features are also the hallmark of childhood asthma, some investigators have hypothesized or in some cases have actually shown a link with toxocara infection [2,7–14]. Similarly, some of the central nervous system features of toxocariasis have been implicated as a cause of occult seizures, mental retardation, and developmental delays [3,4,15]. Because pica is a risk factor for both toxocariasis and lead ingestion [16], it is possible that an element of the cognitive and mental deficits ascribed to toxocariasis may partially result from plumbism.

There are an estimated 73 million dogs and 90 million cats in the United States [17]. Many pups are born with congenital canine toxocariasis and large numbers of both dogs and cats are either stray animals or pets that are not routinely dewormed as recommended by the American Veterinary Medical Association [18]. Such huge numbers of Toxocara-infected dogs and cats serve as rich sources of eggs in the environment, which have been recovered in poor urban areas [16] as well as in rural areas, especially in the American South and Appalachia [19–21]. Most of the prevalence estimates for toxocariasis in the US are based on serological surveys with banked sera that detect Toxocara-specific antibodies [17,20,22]. The enzyme immunoassay (EIA) using T. canis excretory-secretory (TES) antigens from infective-stage larvae is the most useful diagnostic test for toxocarial visceral larva migrans and ocular larva migrans and is the assay used by most commercial reference laboratories in the US, including the reference laboratory at the US Centers for Disease Control and Prevention (CDC) [17,20,22–31]. Results from the CDC EIA measure total immunoglobulin antibodies and are reported as a titer; the assay detects infections caused by both T. canis and T. cati. Visceral larva migrans and some forms of covert toxocariasis, the sensitivity and specificity of the Toxocara EIA is estimated at 78% and 92%, respectively, at a titer of 1:32 [17,22,26,27]. The sensitivity of the EIA for ocular larva migrans, however, is considerably less [1,28]. Following initial infection, Toxocara larvae migrate through host tissues for several months, and ultimately generate a host granulomatous response, which

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blocks further larval migration. However, the larvae may remain alive within the host for months, and host antibody levels may remain strongly positive for 2 or 3 years or more [17,31]. Therefore, in the CDC EIA, the presence of antibody titers greater than 1:32 may be considered reflective of active infection, although we are not aware of careful studies that have determined the length of persistent toxocaral antibodies over long periods of time.

Using a nationally representative set of banked sera, the CDC has undertaken two major national surveys for toxocariasis [17,20,22]. The first was reported more than 20 years ago using sera from children aged 1 to 11 that were collected during the first Health and Nutrition Examination Survey (HANES I) of over 23,000 persons 1 to 74 years of age in 35 geographic regions from 1971 to 1973 [20]. Nationwide, the overall prevalence was found to vary between 4.6% and 7.3%, but ranged as high as 10% in the American South and over 30% for socioeconomically disadvantaged African American children [20]. Higher seroprevalence was also linked to markers of low socioeconomic status, including poverty and crowding and lower educational level for head of household [20]. In 2008, the CDC again reported on *Toxocara* seroprevalence from the Third National Health and Nutrition Examination Survey (NHANES III), a cross-sectional survey conducted between 1988 and 1994 [17,22]. The survey sampled at higher rates specific minority groups (e.g., non-Hispanic blacks and Mexican Americans) and age groups (young children and the elderly) [17]. Based on a representative sample of just over 20,000 in individuals over the age of 6, the overall seroprevalence was 13.9% [17,22], suggesting that tens of millions of Americans are infected with *Toxocara*. However, the seropreva-

![Figure 1. The Life Cycle of Human Infection with *Toxocara canis*.](http://phil.cdc.gov). doi:10.1371/journal.pntd.0000400.g001
Toxocara larva in liver of child necropsied in New Zealand. Larva discovered at some distance from lesion. Image courtesy of CDC and DPDx.

