The Impact of COVID-19 Pandemic on the Battle Against Toxocariasis

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Abstract: Toxocariasis is a neglected zoonotic disease caused by intestinal parasites under the genus *Toxocara* that affects millions of people worldwide. This parasitic disease has been considered to be significantly prevalent in school-age children from impoverished areas in the tropics and sub-tropics, as well as in developed countries. As the global COVID-19 pandemic spreads, it impacts negatively on people who are already dealing with a heavy burden of these parasites which has the potential to induce gastrointestinal, neurological, and other health complications. The ongoing pandemic may alter parasitic disease diagnosis, prevention, and elimination efforts. The aim of this review is to determine the clinical manifestations of toxocariasis and the impact of COVID-19 pandemic in the diagnosis, public health importance, implementation of control and elimination strategies. The relevance of this zoonotic infection increases when human and animal population expand, and when demographic shift, global and climatic change occurs. The pandemic influences the course of *Toxocara* spp. infections especially that people are forced to be in their work from home schemes making them more exposed and increasing the chances of toxocariasis transmission due to close proximity of humans from their pet animals, particularly dogs and cats. Severe infections with these parasites may induce serious health consequences if misdiagnosed and left untreated. Limiting *Toxocara* spp. infection in dogs and cats lowers the number of infectious eggs in the environment, thereby decreasing the chance of human infection. Therefore, continuous surveillance is required to detect the burden of toxocariasis, which needs rapid and precise diagnosis, as well as strict implementation of control and elimination programs. Updated data and researches will also be relevant to contribute to a better knowledge that will help to adapt and reformulate innovative strategies to control, prevent and eliminate toxocariasis under the new normal.

Key Words: Toxocariasis; COVID-19 pandemic; zoonotic; cats; dogs

1. INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic is posing a major and unforeseen threat to the world. Countries had to swiftly adapt and respond in order to stop the virus from spreading and provide treatment to people who have been infected. In the forthcoming months and years, the COVID-19 pandemic is anticipated to disrupt health systems all over the world, particularly in low and middle-income nations. The stress that the pandemic poses on health systems might have an influence on the control, treatment, and elimination of neglected tropical diseases (NTDs), particularly in resource-constrained areas where health services are already struggling to meet population demand (Adepoju, 2020; Hussein *et al.,* 2020).

Toxocariasis is a neglected parasitic zoonotic infection caused by nematodes of the genus *Toxocara,* prevalently found in dogs, cats, and humans which has a considerable socioeconomic impact, particularly on impoverished communities worldwide (Chen *et al.,* 2018). Majority of cases have been recorded in Australia, Eastern and Western Europe, Hawaii, Mexico, Philippines, China, South Africa, and Southeastern United States. Among these locations, Philippines, South Africa, and China are the most

affected by this parasitic disease with prevalence rates as high as 40% or more (Fan *et al.,* 2013). Poverty, open defecation, lack of proper hygiene, insufficient sanitary facilities, poor eating habits, and lack of disease awareness are all factors that contribute to toxocariasis being a persistent public health concern (Belizario *et al.,* 2013).

Due to the complex epidemiology of toxocariasis across the globe, little is known about these parasitic diseases, especially when it comes to the vulnerability of children and adults living with dogs and cats as reservoir hosts. The lack of information and the long-term consequences of poor disease awareness among those at risk, as well as increased poverty, a fragmented health-care delivery system, and discontinued implementation of control programs due to the restrictions caused by the COVID-19 pandemic, have all hindered the elimination of these parasitic diseases in the affected countries. The aim of this review is to determine the clinical manifestations of toxocariasis and the impact of COVID-19 pandemic in the diagnosis, public health importance, implementation of control and elimination strategies. This will aid in providing accurate and updated information that are needed to fuel and reformulate the present public health strategies to combat these diseases during and beyond the pandemic.

2. CLINICAL MANIFESTATIONS OF *TOXOCARA* SPP.

The majority of affected persons are asymptomatic but *Toxocara* larvae can cause harm to tissues and organs in certain individuals. Toxocariasis symptoms vary depending on the affected organ, the severity of the infection, and the intensity of the human inflammatory response (CDC, 2019). Human toxocariasis has been systematically divided into four groups namely visceral larva migrans syndrome (VLM), neurological toxocariasis (NT), ocular larva migrans syndrome (OLM), and covert toxocariasis (CT) with OLM and VLM being the most common (Despommier, 2003).

Ocular toxocariasis occurs when larvae move into the eye and cause symptoms such as vision loss, retinal damage, or inflammation. Multiple retinal and vitreous hemorrhages, granulomatous lesions with or without larvae, and eosinophilic abscesses were discovered during histopathological tests. OLM arises mostly unilaterally as bilateral ocular involvement has been rarely documented. Visual impairment, leukocoria, retinal detachment, strabismus, vitreous mass or haze, virtutis, solid retinal mass primarily at the posterior pole, endophthalmitis, cataract, papillitis, and uveitis are the most common clinical manifestations. Blindness and secondary glaucoma are two possible clinical outcomes of OLM. Visceral toxocariasis, on the other hand, is characterized by larval migration into many organs of the body, including the liver and the central nervous system (Parija, 2017). The primary cause of VLM symptoms is assumed to be an acute hypersensitivity reaction to the death of larvae. Young children of less than five years old are the most commonly affected and they typically appear with abdominal pain which is most likely attributable to hepatomegaly and splenomegaly, as well as fever and lower respiratory symptoms such as bronchospasms, coughing, and asthma caused by bronchitis or parasitic pneumonia (Strube *et al.,* 2013). Leukocytosis, hypergammaglobulinemia, and persistent eosinophilia are typical laboratory findings in affected individuals. Other organ involvement may develop including arthritis, myocarditis, nephritis, and myalgia with eosinophilic polymyositis. VLM has also been linked to dermatological alterations such as rash, eczema, pruritus, urticaria, panniculitis, and vasculitis. Although most *T. canis* infections are undetected, long-term repercussions such as the development of asthma and the promotion of lung fibrosis are suspected (Holland and Smith, 2006).

There have been few recorded cases of neurological toxocariasis. Various animal tests have revealed regular CNS involvement in paratenic hosts. *Toxocara* spp. larval migration to the human brain is usually not associated with clinical central nerve symptoms, but in rare cases can result in eosinophilic meningitis, myelitis, encephalitis, or a combination of pathological presentations. Cerebral lesions are mostly seen in the white matter, although blockage of cerebral arteries has also been documented. Clinical symptoms range from headache, fever, photophobia, weakness, disorientation, and visual impairment to epileptic convulsions, dementia, cognitive abnormalities, and depression, depending on the specific pathology (Moreira-Silva *et al.,* 2004). Taylor *et al.* (1987) described a nonspecific clinical condition in children caused by *Toxocara* spp. as covert toxocariasis. Unspecified symptoms may include anorexia, fever, nausea, vomiting, stomach discomfort, limb aches, headache, pharyngitis, cervical lymphadenitis, sleep and behavior disturbances, cough, pneumonia, and wheeze (Taylor *et al.,* 1987). Severe infections with these parasites may induce serious health consequences if misdiagnosed and left untreated.

3. DIAGNOSIS OF TOXOCARIASIS

Toxocariasis is mainly diagnosed by indirect measures, notably serology, because larvae

are trapped in tissues and are difficult to detect morphologically. While seeing larvae in histologic sections offers a clear diagnosis, capturing a larva in a small biopsy specimen is difficult. Since *Toxocara* larvae do not mature into adults in humans, a stool examination would detect no *Toxocara* eggs. A preliminary diagnosis for both VLM and OLM is based on clinical symptoms, a suitable exposure record, laboratory findings including eosinophilia, and the presence of antibodies to *Toxocara*. Antibody detection tests are the only way to confirm a clinical diagnosis of ocular larva migrans and visceral larva migrans. The enzyme immunoassay (EIA) containing larval stage antigens released in vitro by cultivated third-stage larvae or taken from embryonated eggs is the recommended serologic test for toxocariasis. *Toxocara* excretory-secretory (TES) antigens are superior to larval extracts because they are easier to generate and do not require an absorption purification phase to achieve optimal specificity (CDC, 2019).

Despite growing efforts to develop a number of diagnostic procedures for human toxocariasis detection, accurate and reliable diagnostic test remains to be a challenge. In comparison to conventional diagnostics, molecular techniques provide a high analytical specificity and faster turnaround times. *T. canis, T. cati,* and other ascarids recovered from feces or soil have been accurately identified and phylogenetically analyzed utilizing polymerase chain reaction (PCR) tests such as quantitative real-time PCR (qPCR), PCR-restriction fragment length polymorphism (PCR-RFLP), and PCR- Randomly amplified polymorphic DNA (PCR-RAPD) based on a number of genetic markers (Overgaauw *et al.,* 2013). The introduction of loop-mediated isothermal amplification (LAMP) of nucleic acid has enabled a rapid and low-cost method for determining the presence of *Toxocara* eggs in soil (Macuhova *et al.,* 2010). Toxocariasis diagnosis might be addressed by using molecular approaches with improved specificity characteristics.

The COVID-19 pandemic has a major impact on parasitological diagnosis of toxocariasis. Many laboratories had to postpone or limit their regular parasitological testing duties in order to undertake SARS-CoV-2 tests, which had a substantial influence on the number of human parasitic infections detected (Głuchowska *et al.,* 2021). Most laboratories have noticed a decrease in the number of parasitological diagnostic tests requested and conducted which may induce inaccuracy on the actual number of cases. This has a significant influence on the roadmaps for NTDs, including parasitic infections (Adepoju, 2020).

4. PUBLIC HEALTH IMPORTANCE

Toxocariasis is still a major public health concern and *T. canis* is one of the most common and widespread zoonotic parasite species, ranging from the subarctic to the tropics (Jenkins *et al.,* 2013). There are a number of factors that have been linked to greater incidence of *Toxocara* infection. In most cases, humans are infected by the accidental oral ingestion of embryonated *Toxocara* spp. eggs from contaminated soil on unwashed hands or raw vegetables. Infection can also be acquired by ingesting larvae found in undercooked meat or offal from infected paratenic hosts such as chickens, ruminants, or pigs. *Toxocara* eggs hatch once inside the body, and the larvae can migrate through the circulation to many regions of the body, including the eyes, liver, brain, heart, muscles, and lungs (CDC, 2019). Toxocariasis, the disease produced by these migratory larvae, induces eye problems liver inflammation, fever, and coughing (Fahrion *et al.,* 2011).

Toxocara spp. has a diverse spectrum of wild animal definitive hosts. Dogs and cats are the most important definitive hosts for toxocariasis, particularly in developing countries. Most of these animals have access to public places, serving as the primary source of soil contamination and offering a significant risk of human infection with infective eggs (Rostami *et al.,* 2020). Environmental contamination with *Toxocara* spp. eggs has been found in large quantities at back yards, sandpits, parks, playgrounds, lake beaches, and other public sites (Mizgajska-Wiktor and Uga, 2006).

Toxocara infection is more common in children and teenagers under the age of 20 (Fan *et al.,* 2013). Children are especially at risk of toxocariasis due to close contact with dogs and their behavior of putting things in their mouths, eating soil, playing in outdoor environments where cat and dog feces are present, and poor hygiene. Embryonated *Toxocara* spp. eggs have also been found in dog hair, indicating that direct human-dog contact might be a source of infection for humans (Roddie *et al.,* 2008).

Considering *Toxocara* is more abundant in hot, humid places where eggs are kept viable in the soil, geographic location plays a role as well (McGuiness, 2014). Poverty, a lack of education, and issues with uncontrolled and untreated definitive host populations will result in extensively contaminated habitats, which will give optimal transmission opportunities under warm climatic conditions (Congdon, 2011). In most developing and some developed countries, massive populations of untreated owned, stray, or feral dogs and cats serve as a continuing reservoir of infection, environmental egg contamination, and potential sources of infection to

humans and other paratenic hosts (Macpherson, 2013).

When an individual owns a dog or a cat, he is more likely to get infected with *Toxocara* spp. (Congdon, 2011). The ongoing pandemic has forced people to stay at home to limit the movement of individuals and prevent further transmission of COVID-19 infections. The government has implemented lock-downs and community quarantine restrictions which led to work from home set-ups that increased the prolonged exposure of human population to animal pets making them more susceptible in acquiring these zoonotic parasitic diseases. The fast growth in the number of dogs and cats, particularly uncontrolled feral and stray populations, as well as their close contact to humans, has raised the risk of *Toxocara* spp. infection in humans. The lack of an efficient strategy for controlling *Toxocara* eggs makes eliminating this parasite from the environment difficult. As a result, infection-prevention strategies should include measures to prevent early contamination of the environment.

5. CONTROL AND ELIMINATION STRATEGIES

Soil-transmitted helminths (STH), including *Toxocara* spp., are intestinal parasites that infect about more than 1.5 billion individuals worldwide. Current treatment programs are geared at reducing morbidity through school-based deworming and treating women of reproductive age (WRA), since these two groups are thought to have the highest morbidity. The World Health Organization recommends mass drug administration (MDA) using anthelmintics such as albendazole, mebendazole, and thiabendazole to school-age children (SAC) to minimize morbidity caused by STH infections in endemic regions (Werkman *et al.,* 2020). Since reinfection is common due to everyday activities and environmental factors, it is necessary to continue the MDA program at regular intervals in order to have a considerable decrease in parasitic infection prevalence and maximize the program's effectiveness (Jia *et al.,* 2012). However, with the lowest public health systems, developing countries are indeed battling the most infectious disease burdens due to inadequate health funding, personal protective equipment, supplies of medications, and intensive care professionals. Since the majority of their healthcare systems rely on foreign assistance for disease control and prevention initiatives, attempts to manage COVID-19 will have an influence on efforts to control other endemic health concerns.

Due to the focus on COVID-19 from the beginning of the pandemic, there has been a pause in the fight against parasitic diseases, which has resulted in an increase in cases of soil-transmitted helminthiasis, including toxocariasis (Hussein *et al.,* 2020). The implementation of policies which delivers the fundamental strategies of the NTD prevention, control, and elimination programs have been compromised by the pandemic. All community-based disease prevention and health promotion services have been halted. Specifically, the monitoring and control of major NTD initiatives has been discontinued at the national level, and the preparation for mass drug administration initiatives has also been substantially hampered at the regional level (Maliza *et al.,* 2021). As a result, efforts to mitigate this surge should be continued as soon as possible by implementing additional global measures.

Controlling *Toxocara* infection in dogs and cats reduces the number of infectious eggs spreading in the environment and thus reduces the risk of infection for humans. Regular deworming of dogs and cats at an early age, according to the veterinarian's guidelines is a must to help reduce possible infections, especially when pets roam outside in areas where they are susceptible to infection (CDC, 2019). In order to promote awareness and begin initiatives to control the spread of parasites carried by dogs and cats in different communities and households, regular parasitic surveillance is required. This is attributable to the fact that practically every family keeps these animals as pets, and they might become carriers of these diseases if they come from various sources such as shelters that have been domesticated or puppies and kittens acquired from breeders (Chen *et al.,* 2018). Not only is health education important for raising public awareness about altering behavior and implementing risk-reduction measures but it also helps with diagnosis, control, and treatment (Camon, 2017).

An integrated one-health approach offers hope for eliminating soil-transmitted helminth infections including toxocariasis worldwide. Social adjustments that prevent toxocariasis such as prohibiting open defecation practices and direct exposure to soil will be beneficial. Apart from effective education and advice for citizens, the cooperation of local governments in the building of sanitary container infrastructures will be valuable (Grimmes *et al.,* 2015).

6. CONCLUSION

Toxocariasis remains to be a health problem around the world, producing multisystem disease, particularly in school-age children. The prevalence of

parasite infection in dogs and cats is generally high, posing a threat of zoonotic transmission from these animals to people. Cohabitation of humans with dogs and cats increases *Toxocara* transmission. Contact with infected cats and dogs, particularly kittens and puppies, is a risk factor for infection, which is cause for concern in terms of public health given the rising prevalence of dogs and cats in urban areas.

Due to its magnitude, COVID-19 has a significant impact on the diagnosis, prevention, and elimination programs for neglected tropical diseases such as toxocariasis. In endemic areas, resumption of programs to prevent, control, and treat these parasitic diseases might assist to lower the incidence and morbidity. Therefore, there is a need for continuous surveillance to better identify the burden of toxocariasis, which necessitates prompt and accurate diagnosis. There is also a need to develop and deploy novel medications and vaccines to address clinical infection, as well as continued research not just in establishing adequately focused preventative techniques, but also in understanding *Toxocara* spp. infection biology as well as human reactions to them.

7. RECOMMENDATION

Several actions may be taken to prevent the transmission of *Toxocara* eggs from animals to people. These include deworming family pets on a regular and early basis. Puppies, kittens, and pregnant animals should be given special attention and preventive anthelmintics since they are the most susceptible to spread the disease. Pet owners should also collect and dispose of pet feces in a safe and sanitary manner before the eggs become infective.

In addition, molecular characterization of *Toxocara* isolates from environmental and clinical sources must be established to determine novel biomarkers epidemiological surveys and diagnosis of *Toxocara* infection. This information may aid in the establishment of a database that includes behavioral, climatic, demographic, ecological, and socioeconomic factors, as well as the development of prophylactic or therapeutic vaccines, hence, should be ongoing research directions. The effective completion of these research areas can contribute to a better understanding of toxocariasis and motivate the development of innovative strategies to prevent *Toxocara* infection, minimize its socioeconomic impact, and progress toward the elimination of these parasitic diseases.

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