International Annals of Science
ISSN: 2456-7132
Volume 9, Issue 1, pp. 24-32, 2020
DOI: https://doi.org/10.21467/ias.9.1.24-32

RESEARCH ARTICLE

Prevalence of Intestinal Helminth Infections of Stray Dogs of Public Health Significance in Lagos Metropolis, Nigeria

Olatunji Ayodeji Abulude*

Department of Biological Sciences, Faculty of Science, Nigeria Police Academy, Kano State

* Corresponding author email: abuludeolatunji@polac.edu.ng

Received: 18 October 2019 / Revised: 12 November 2019 / Accepted: 16 November 2019 / Published: 16 November 2019

Abstract

Globally, stray dogs have been a major source of zoonoses such as cutaneous larval migrans, visceral larval migrans and hydatidosis. These dogs are recognized as being a major public health problem where their population is unchecked. This study was conducted to determine the prevalence of intestinal helminth parasites of stray dogs in Lagos metropolis. Stools of 96 stray dogs were examined microscopically for ova of these parasites using centrifugation flotation method. Four species of intestinal helminths were identified. The overall prevalence of helminths infection was 61.4%, with *Ancylostoma caninum* having a prevalence of 62.5%, *Toxocara canis* 20.8%, *Dipylidium caninum* 18.7% and *Strongyloides stercoralis* 2.0%. *T. canis* had the highest worm burden of 1,250 egg per gram (EPG) while *S. stercoralis* had the least (100 EPG). The areas with the most helminth infections were Yaba (n=12, $\bar{X}$=1.58, SD=0.793), Agege (n=11, $\bar{X}$=1.73, SD=0.786) and Ikotun (n=11, $\bar{X}$=1.45, SD=0.820). *S. stercoralis* was only found in samples obtained from Mushin and Ikorodu. Most of the stool samples obtained from this study had mixed infections, 83.3% were infected with three helminth species, 8.3% were infected with four helminth species and none had double infection. Mushin had the most mixed infections (n=4, $\bar{X}$=1.900, SD=1.101) while Obalende had the least (n=1, $\bar{X}$=1.000, SD=0.000). Most of the intestinal helminth parasites identified in this study are zoonotic and thus pose a public health problem. Environmental factors seem to influence the health condition of these dogs, thus concerted efforts should be made to reduce the growing population of stray dogs on the street of Lagos.

Keywords: Helminth Parasites, Prevalence, Public Health, Stray Dog, Sanitation, Nigeria

1 Introduction

Out of close to a billion dogs that are in existence globally, it is estimated that about one-fifth of this figure are stray dogs [1]. Due to their free roaming nature, stray dogs are often exposed to different adverse environmental conditions, germs and helminth parasites. Some of these parasites that are found in stray dogs can in turn pose a major threat to human health when people are exposed to it. Out of over one thousand known human diseases caused by pathogens, about 896 are contacted from animals [2] and almost all dogs harbour one or more zoonotic species of intestinal parasites [3].

Intestinal helminths seen in stray dogs are roundworms, hookworms, tapeworms, whipworms and threadworms. The prevalence of dog intestinal helminth infection in sub-Saharan and West Africa is 71% and 59% respectively. *Ancylostoma* is the most commonly encountered species of intestinal helminth in these regions [4]. Recent studies in Nigeria put the overall prevalence of intestinal helminth of dogs between 32%-56% [5-7]. Important zoonoses transmitted from dogs include visceral larva migrants, cutaneous larva migrants, hydatidosis and strongyloidiasis. Transmission of these infections may occur from dogs to humans directly or indirectly [8]. It takes about 7 days before the eggs of roundworm become infectious when passed out in dog's faeces and the eggs of this helminth can become viable for many years. Rarely, *Toxocara canis* can cause infection in human, once they come in contact with dog stools. Visceral or ocular

larva migrans in humans are caused by *T. canis* and children are the most vulnerable. Infection is via the fecal-oral route and severe infection may cause shortness of breath among other symptoms. Also, eyes and cerebral involvement with seizures may occur [8-11]. The prevalence of dog toxocara infection in West Africa is approximately 21% [4]. Ova of *Ascaris* species have been seen in the dog's faeces and this shows that it can be transmitted to humans from dogs. About 94% of helminth infections in dogs are caused by hookworms. Cutaneous larva migrans in human is caused by cutaneous contact with the infective stages of *Ancylostoma* species [3], [10]. The prevalence of dog *Ancylostoma* infection in West and sub-Saharan Africa is 28% and 41% respectively [4]. *Echinococcus granulosus* is a zoonotic tapeworm causing echinococcosis in dogs and is usually symptomless. However, in man, it causes hydatic disease also known as cystic echinococcosis especially among children. These cysts are mainly formed in the liver and lungs. Infection occurs when fertile eggs or proglottids are ingested and oncospheres are released in the intestine [1], [11]. The prevalence of *Dipylidium caninum* in sub-Saharan Africa is 20% [4]. It is also one of the common parasites found in dogs. The ova of *Hymenolepis* (dwarf tapeworm) have been seen in the stools of dogs [3]. *Trichuris trichiura* is a species of dog whipworm that have been recovered from humans on rare occasions despite having a high degree of host specificity. Most *Trichuris* infections are probably asymptomatic, but in long term infection, heavy worm burdens can develop [10]. Canine strongyloidiasis is a zoonotic infection caused by *Strongyloides* (a species of dog threadworm). This rare infection is common in areas where stray dogs are highly prevalent [11], [12].

Lagos is arguably the most populous city in Nigeria, the second fastest-growing city in Africa and the seventh in the world. According to the Lagos State Government [13], the city population is said to be around 20 million, making Lagos one of the largest cities in the world. However, the estimated population of the city is put above 12 million by the National Bureau of Statistics [14]. Lagos like other major cities in developing countries have a lot of stray dogs due to its large population size and these dogs roam about freely and tend to defecate in open areas which can pose a serious health risk to the city inhabitants. This study was carried out to determine the prevalence of intestinal helminth parasites of stray dogs in Lagos metropolis and to point out the public health significance of these parasites.

2 Materials and Methods

2.1 Study Area

The study was conducted in Lagos, Nigeria. The state is made up of 20 Local Government Areas comprising three senatorial districts. Its coordinate is latitude 6°2´N to 6°4´N and longitude 2°45´E to 4°20´E [15]. Samples were collected from twelve residential cities in Lagos metropolis. These include Abule-Egba, Agege, Ajegunle, Ikeja, Ikorodu, Ikotun, Ijora, Oshodi, Obalende, Mushin, Mile-2 and Somolu.

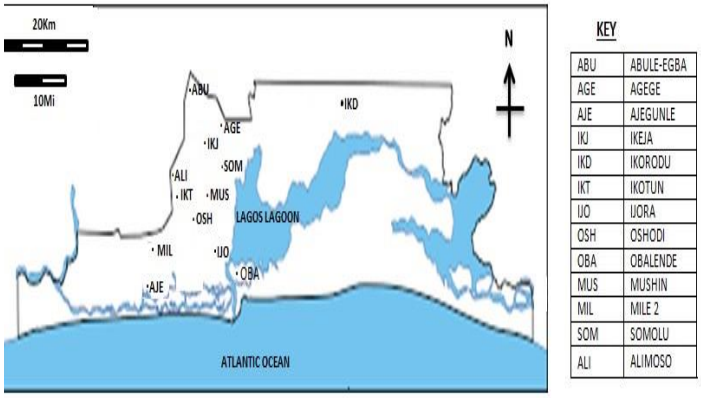

Figure 1: *Map of Lagos, Nigeria showing the twelve sampling areas.*

2.2 Sample Collection

Sampling sites were selected using the map of Lagos metropolis. Eight fresh stool samples of stray dogs were randomly collected from the streets and parks of each city in a clean and properly labeled sampling bottle. In all, 96 stool samples were collected from these areas and were taken to the parasitology laboratory of the Nigerian Institute of Medical Research, Yaba, Lagos, Nigeria for microscopic examination.

2.3 Processing and Microscopic Analysis of Stool Samples

Stool samples were examined for the presence of cestode's proglottids after which centrifugation flotation method was performed for ova

identification. From each sample, 2 g of blood and mucus free stool was weighed and was mixed with 10 ml of flotation solution 1 (this was prepared by dissolving 386 g of the zinc sulfate in 1000 ml distilled water) using a glass rod and the mixture was poured through a tea strainer into a beaker. The strained solution was then transferred into a 15 ml centrifuge tube for centrifugation at 1200 rpm for 5 minutes. Fresh flotation solution was added into the mixture by gently inserting the pipette and delivering the solution below the surface of the mixture until it filled to the brim with a slightly inverted meniscus forms on the centrifuge tube. A coverslip was gently placed on the meniscus without splitting the mixture. The tube with the coverslip was left to stand in an upright position for 10 minutes. The coverslip was gently removed and placed on a microscopic slide containing a drop of Lugol's iodine to aid visibility of ova. It was then examined with a compound microscope using 10x and 40x objective lenses for ova identification. Parasites were identified based on morphology to the family, genus and species level. Ova enumeration was done using McMaster's technique. Four grams each of the stool sample was transferred into a beaker containing 56 ml of flotation solution 2 (this solution was prepared by weighing 400 g of sodium chloride and dissolving it in 1000 ml distilled water. Five hundred grams of simple sugar was then added and allowed to dissolve by stirring continuously for five minutes). It was mixed thoroughly using a stirring rod. The mixture was then filtered into another beaker. While stirring the filtrate, some of it was transferred into a McMaster's counting chambers using a pasteur pipette. The chamber was allowed to stand for 5 minutes before mounting on a compound microscope. The entire engraved area of the chambers was examined using a 10 x 10 magnification. Helminths ova were counted [16-19].

2.4 Data Analysis

IBM SPSS statistical software version 20.0 (IBM Corp. Armonk, New York, USA) was used for data analysis and presentation. Descriptive statistical tools used for data presentation, description and evaluation include frequency, percentage, bar chart, doughnut, mean and standard deviation.

3 Results

In this study, different species of intestinal helminths were identified. As shown in Figure 2, out of the 96 samples examined, 62.5% were infected with *Ancylostoma caninum,* 20.8% with *Toxocara canis,* 18.7% with *Dipylidium caninum* and 2.0% with *Strongyloides stercoralis.* Figure 3 showed that the overall prevalence of helminth infection was (59/96) 61.4%.

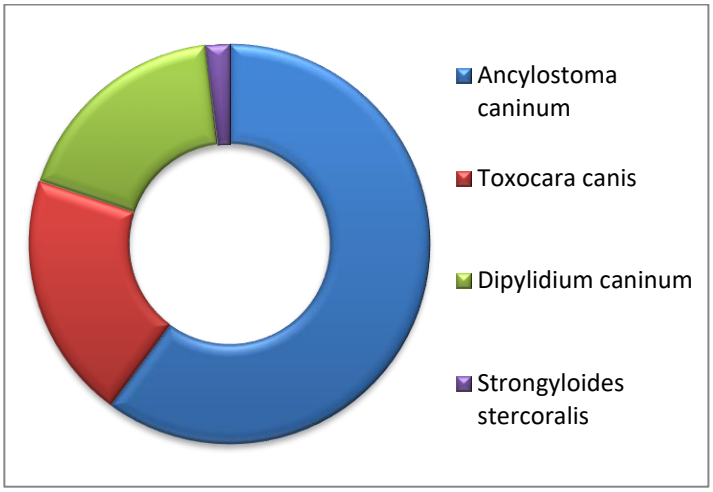

Figure 2: *Prevalence of the different intestinal helminth infections identified in the stools of stray dogs in Lagos metropolis.*

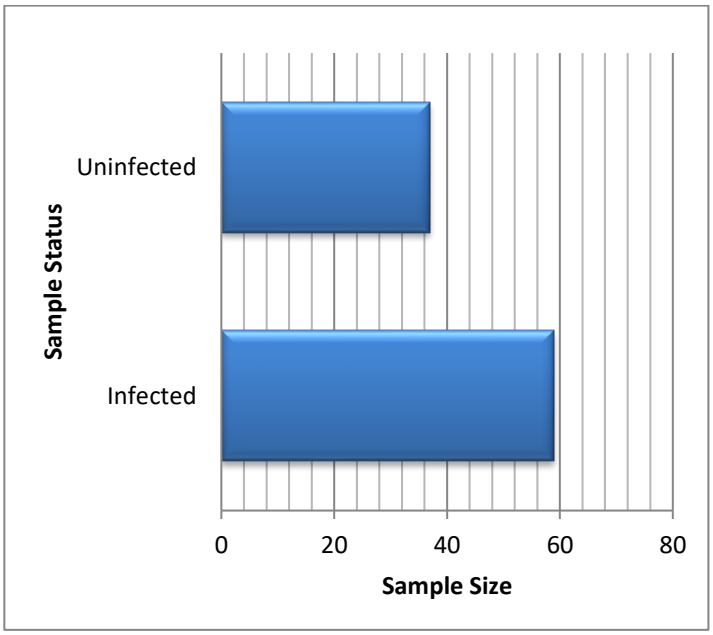

Figure 3: *Overall prevalence of infected stool samples with intestinal helminths in Lagos metropolis.*

Table 1: *Distribution of intestinal helminth infections of stray dogs in different cities within Lagos metropolis, Nigeria.*

Parasites Area	*A. caninum* n=8 Number of infected sample (%)	*T. canis* n=8 Number of infected sample (%)	*D. caninum* n=8 Number of infected sample (%)	*S. stercoralis* n=8 Number of infected sample (%)	$\bar{X}$	SD
Yaba	7 (87.5)	3 (37.5)	2 (25.0)	0 (0.0)	1.58	0.793
Somolu	4 (50.0)	2 (25.0)	2 (25.0)	0 (0.0)	1.75	0.886
Agege	5 (62.5)	4 (50.0)	2 (25.0)	0 (0.0)	1.73	0.786
Ikeja	3 (37.5)	1 (12.5)	1 (12.5)	0 (0.0)	1.60	0.894
Mile 2	4 (50.0)	1 (12.5)	1 (12.5)	0 (0.0)	1.50	0.837
Ijora	3 (37.5)	1 (12.5)	2 (25.0)	0 (0.0)	1.83	0.983
Oshodi	2 (25.0)	3 (37.5)	2 (25.0)	0 (0.0)	2.00	0.816
Obalende	5 (62.5)	0 (0.0)	0 (0.0)	0 (0.0)	1.00	0.000
Mushin	5 (62.5)	2 (25.0)	2 (25.0)	1 (12.5)	1.90	1.101
Ikotun	8 (100.0)	1 (12.5)	2 (25.0)	0 (0.0)	1.45	0.820
Ikorodu	8 (100.0)	1 (12.5)	0 (0.0)	1 (12.5)	1.40	0.966
Ajegunle	6 (75.0)	1 (12.5)	2 (25.0)	0 (0.0)	1.56	0.882
Total (Prevalence)	**60 (62.5)**	**20 (20.8)**	**18 (18.7)**	**2 (2.0)**		

N=96, $\bar{X}$ denotes mean; SD denotes standard deviation; N denotes total sample size; n denotes area sample size.

As shown in Table 1, *A. caninum, D. caninum* and *T. canis* were widely distributed across the cities with some areas having more helminth infections than others. The Table also showed the mean and standard deviation of the distributions.

As shown in Table 2, *T. canis* had the highest intestinal worm egg burden per gram of faeces while *S. stercoralis* had the least.

Table 2: *Estimated intestinal worm burden of Lagos stray dogs*

Parasite Ova	Average Ova Count	EPG
A. caninum	17	850
D. caninum	6	300
T. canis	25	1,250
S. stercoralis	2	100

EPG denotes Egg Per Gram of faeces. EPG was calculated using the following formula: (Number of eggs in McMaster chamber 1) + (Number of eggs in McMaster chamber 2) X 50= EGP

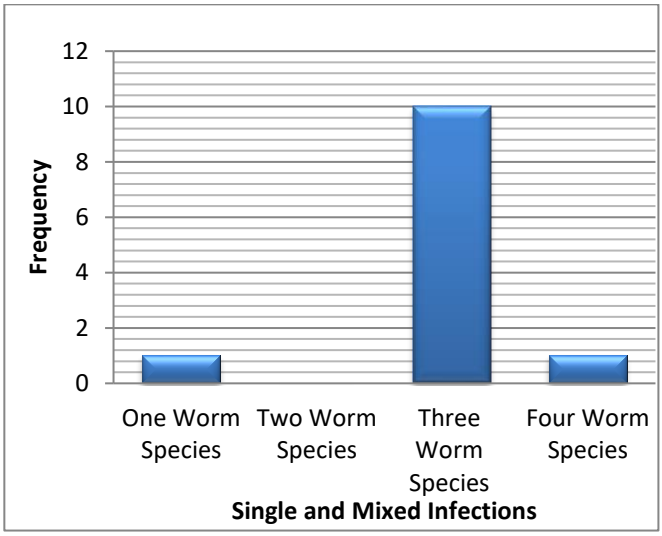

Figure 4: *Prevalence of single and mixed helminth infections among stray dogs in Lagos metropolis.*

As shown in Figure 4, most of the stool samples obtained from infected stray dogs had mixed infections, 83.3% were infected with three helminth species, 8.3% were infected with four helminth species and none had double infection.

4 Discussion

Few studies in Nigeria have demonstrated the presence of ova of intestinal helminths in the stools of dogs [5-7], [9], [20-21]. Some of the helminth ova observed in this study were reported in other studies conducted in other parts of the world [22-32]. The report of these various studies showed that species of *Ancylostoma*, *Toxocara* and *Dipylidium* are the most widely distributed gastrointestinal helminth parasites of stray dogs globally, while *S. stercoralis* seems to be the least. However, other studies have identified some other species of gastrointestinal helminths like *Ascaris* species, *Trichuris trichiura* [3], *Taenia* species, *Mesocestoides* species [33], *Toxascaris leonine* [28], *Uncinaria stenocephala*, *Trichinella* species [34], and *Heterophyes heterophyes* [32]. It was observed that the distribution and prevalence of these parasites differ slightly from one study area to another. This may be due to differences in the dog population and how clean or dirty these places are. The occurrence of mixed infections as observed in this study is a common occurrence in most studies conducted to determine the prevalence of intestinal helminths [20-21], [25], [35]. The overall prevalence of intestinal helminth infection of 61.4% observed in this study is lower to the findings of the study conducted by Geraili *et al.* [33] which was 73.3%, and 95% reported by Das *et al.* [36], but higher than 43.3% reported by Ayinmode *et al.* [20], 46.7% reported by Satyal *et al.* [23], 35.7% reported by Rojekittikhun *et al.* [25], and 56.1% reported by Idika *et al.* [37]. The relatively high prevalence of intestinal helminth infections seen in this study may be due to the large number of stray dogs present in Lagos. According to Hambolu *et al.* [11], the ratio of male to female dog in Lagos metropolis is 1:2, while dog to human ratio is 1:6. Although the number of stray dogs in Lagos is unknown, the city's estimated dog population is said to be 1,527,718 with more than half of this being stray dogs. Thus, the population of stray dogs in Lagos will probably exceed those reported in other places, worldwide. According to Ancy *et al.* [38], there were around 268,994 street dogs in Kerala, India in 2015. In Istanbul, the estimated number of stray dogs in 2006 was 56, 734, and about 107, 228 stray dogs were picked up in the United Kingdom in 2009. This figure is even higher in other places. For instance, the number of stray dogs in Italy in 2001 was said to be around 816, 610 [39].

The presence of the ova and larvae of some of these intestinal helminths in the environment is considered to be a potential health hazard which can lead to the transmission of zoonoses. *Ancylostoma* is the most occurred helminth infection in this study. This conforms to other similar studies that reported *Ancylostoma* species as the most prevalent helminth infection [20], [24], [37]. This study identified *A. caninum* as the only *Ancylostoma* species, unlike, Satyal *et al.* [23] that identified five different *Ancylostoma* species out of 98 positive samples. The high prevalence of *Ancylostoma* in this study and other similar studies may be due to the mode of transmission of these parasites among dogs which is usually by direct penetration of the dog's skin by the larva form. This makes transmission to be easy and fast within dog population. The high prevalence of *A. caninum* in this study is a cause for concern because research had shown that this helminth can cause human eosinophilic enteritis [40]. Frequent exposure to larva of this parasite can lead to this zoonotic infection. Its symptoms include dysphagia, nausea, heartburn, diarrhoea, abdominal pain and bloating [41]. Other study showed that occult human *A. caninum* infections are common in places where the population of stray dogs is high [42]. Dog hookworms like *U. stenocephala* and other *Ancylostoma* species like *A. braziliense* and *A. ceylanicum* are also zoonotic. The eggs of these parasites are abundant in places where the number of stray dogs is unchecked, and their larva can easily penetrate the unprotected human skin and lead to cutaneous larva migrans (CLM). CLM cause inflammation of the skin, which leads to serious pruritic eruption. Secondary bacterial infection can develop from wounds caused by CLM [43]. According to the Center for Food Security and Public Health, *A. braziliense* is responsible for most of the zoonotic infections in human while *A. ceylanicum* is the only zoonotic hookworm known to produce patent intestinal infections in humans [44]. *T. canis* also showed high prevalence in this study and there is likelihood of toxocariasis occurring in the studied

area due to the high worm burden of this parasite. Toxocariasis is an accidental human infection acquired by swallowing eggs of a series of related nematode species *Toxocara*. The eggs from these ascarids are common environmental contaminants of human habitation [10]. Higher rates of soil contamination (10-30%) with *Toxocara* eggs have been found globally in the vicinity where children commonly play, like backyards, playing grounds, and recreational parks, and viable eggs can survive for up to fifty-two weeks [11], [26] [45]. Mohammed [10] reported that out of 764 soil samples collected from relaxation parks in Abuja, Nigeria, helminth eggs were found in 68% of the samples studied. This clearly shows that intestinal helminth parasites of stray dogs can contaminate the soil. The present of *D. caninum* ova in this study equally pose a serious health concern because dog tapeworm can cause dipylidiasis when ingested by humans. The first case of dipylidiasis in the United State was reported in 1903 and ever since more cases had been reported worldwide [46]. *S. stercoralis* ova have the least frequency of occurrence in this study. This is because these ova are rarely seen in stool samples. However, it is estimated that 370 million people are infected with Strongyloidiasis globally and the majority of this infection occurred in developing countries [47].

In metropolis such as Lagos, with high prevalence of stray dogs, dog stools can act as a means of transmitting zoonoses, as their stools are not regularly removed from the environment. Most of these stray dogs still return home to their owners at the end of each day, despite the fact that they are not usually well taken care of. This may also contribute to easy transmission of these parasites. Movement of automobiles, motorcycles, tricycles, carts, and bicycles can also help spreads viable pathogens present in these stools from one place to another. Likewise, helminth ova can be brought into people's homes if faeces get stuck to shoes or animals' paws. Additionally, arthropods and other environmental factors such as rain and wind may also play an important role in this regard [24]. Many helminth ova found in stools do not reach the infective stage until several days or weeks after the animal defecated. This is because time allows stools to dry out and break up thus creating an increased risk for exposure to parasites. Most helminth ova can remain viable in soil for months or even years. Humans may become infected if they mistakenly ingest contaminated soil containing helminths ova [8]. Lagos has a lot of open refuse dump sites littered with food waste. Stray dogs seem to be more prevalent in regions where food wastes are in abundance as these dogs tend to feed off these waste foods. According to Ancy *et al.* [38] one of the reasons for the increasing in the population of stray dogs in any society is the lack of waste management system. This might be one of the major reasons for the high prevalence of intestinal helminths seen in this study, because the Lagos waste management system is not so effective especially in residential areas. Mohammed [10] also stressed that faecal pollution, contact with animals, poor hygienic practices and improper disposal of waste are few of the major factors recognized to promote the spread of helminth infection most especially in developing countries. The World Organization for Animal Health (OIE) on Stray Dog Population Control at its 77th General Session adopted the criminalization of the suffering of dogs and also made it an offence to permit dogs to go astray. Nigeria as a member state has taken some steps towards the production of legislation on animal protection and in the eradication of stray dogs. In fact, the first dog law in Lagos was enacted on the 1st of January 1943. However, it has not implemented majority of the OIE's standards into policy or legislation, including those on stray dog control [48-49]. In 2011, the European Union Parliament adopted a resolution on the management of dog population and on responsible ownership rights. Article 12 of the European Convention for the Protection of Pet Animals emphasized on the reduction in the number of stray dogs in member countries. This resolution has helped Holland to become the only country in the world without a stray dog; although, the country was able to reduce the number of stray dogs gradually during the last 200 years [50]. The micro-chipping of dogs is now compulsory since 2012 in Holland and the country has one of the lowest euthanasia numbers and a national animal act, which provides rules for the care and keeping of dogs [51]. The registration of dogs and their

owners can further help reduce the number of stray dogs, for instance, in Pescara, Italy, stray dogs were identified and registered between 2004 and 2008 and this led to a great decrease in the numbers of stray dogs from about 5,000 to 2,300. These dogs can also be adopted by individuals while diseased ones can be subjected to euthanasia. The United Kingdom killed 9,000 stray dogs in 2009 and this has helped in reducing the number of stray dogs on its streets [39].

5 Conclusions

The findings of this study showed that the stools of stray dogs do harbours the ova of zoonotic intestinal helminth parasites. *Ancylostoma caninum* and *Toxocara canis* were the most prevalent infections among stray dogs in Lagos metropolis. With the large population of uncontrolled population of stray dogs in the metropolis, there is the likelihood of zoonotic outbreak if the populations of these dogs remain unchecked. Therefore, due to the close association between humans and dogs, proper management of dogs' population and adequate waste management are recommended. Reducing the number of stray animals must be done and sustained by the combination of political, legal, educational and technological means. The introduction of animal registration and welfare standards at local government level should be done and Lagos State should fully enact the Animal Welfare Act. The Africa Union in which Nigeria is a member state should emulate the European Union in adopting a resolution of the management of the dog population and on responsible ownership rights in Africa.

6 Declarations

6.1 Acknowledgements

The author would like to acknowledge Mr. G. O. Ariyibi of the Department of Biological Sciences, Yaba College of Technology posthumously for his advice and guidance. The author would also like to thank Mr. D. O. Akande of the Nigerian Institute of Medical Research, for providing the necessary technical assistance.

6.2 Competing Interests

The author declares that no conflict of interest exists.

How to Cite this Article

O. Abulude, "Prevalence of Intestinal Helminth Infections of Stray Dogs of Public Health Significance in Lagos Metropolis, Nigeria", *Int. Ann. Sci.*, vol. 9, no. 1, pp. 24-32, Nov. 2019. doi: 10.21467/ias.9.1.24-32

References

[1] World Atlas (2019). How Many Dogs Are There In The World? http://www.worldatlas.com/articles/how-dogs-are-there-in-the-world.html

[2] J. L. Heeney, "Zoonotic viral diseases and the frontier of early diagnosis, control and prevention," *J Intern Med.*, vol., 260, no. 5, pp. 399-408, 2006.

[3] R. J. Traub, I. D. Robertson, P. Irwin, N. Mencke, R. C. A. Thompson, "The Role of Dogs in Transmission of Gastrointestinal Parasites in a Remote Tea-Growing Community in Northeastern India," *Am J Trop Med Hyg*., vol. 67, no. 5, pp. 539-545, 2002.

[4] N. N. Chidumayo, "Epidemiology of canine gastrointestinal helminths in sub-Saharan Africa. *Parasites & Vectors*," vol. 11, no. 100, pp. 1-7, 2018.

[5] K. U. Ezema, S. A. Malgwi, M. K. Zango, F. Kyari, S. M. Tukur, A. Mohammed, B. K. Kayeri, "Gastrointestinal parasites of dogs (*Canis familiaris*) in Maiduguri, Borno State, Northeastern Nigeria: Risk factors and zoonotic implications for human health," *Veterinary World*, vol. 7, no. 12, pp. 1150-1153, 2019.

[6] M.F. Per, P. M. Ikye-Tor, A. E. Uwondo and D. O. Esonu, "Prevalence of *Zoonotic Gastrointestinal Helminth Parasites* (ZGIHP) of Dogs Presented to the Small Animal Clinic of the Veterinary Teaching Hospital, University of Agriculture, Makurdi, Benue State (October 2016-January 2017)," *Scientific Research Journal (SCIRJ)*, vol. 7, no. 8, pp. 73-77, Aug., 2019.

[7] I.K. Idikaa, E.C. Onuoraha, C.F. Obia,b, P.U. Umeakuanac,d, C.O. Nwosua, D.N. Onaha, S.N. Chiejinaa, "Prevalence of gastrointestinal helminth infections of dog in Enugu State, South Eastern Nigeria." *Parasite Epidemiology and Control*, vol. 2, pp. 97-104, May., 2017.

[8] E. Beeler, M. May, "*The Link between Animal Feces and Zoonotic Disease*," Rx for Prevention. LA County Department of Public Health, pp. 4-5, 2011.

[9] C. I. Iboh, R. O. Ajang, J. T, "Abraham. Comparison of gastrointestinal helminthes in dogs and awareness of zoonotic infection among dog owners in Calabar, South Eastern Nigeria," *Afr J Parasitol Res*., vol. 2, no. 1, pp. 41-45, 2014.

[10] F. I. Mohammed, "*The Prevalence of Helminth Eggs in the Soil of Abuja Recreational Parks and Gardens, Abuja, Nigeria,"* A thesis Submitted for the Award of Master of Science Degree in Veterinary Public Health and Preventive Medicine, Ahmadu Bello University, Zaria, Nigeria, pp. 1-78, 2011.

[11] I. W. Fong, "*Emerging Zoonoses A worldwide Perspective,"* Springer, pp. 15-38, 2017.

[12] S. Umur, Y. Meral, C. S Bolukbas, A. T. Gurler, M. Acici, "First clinical Strongyloides stercoralis case in a dog in Turkey," *Turk J Vet Anim Sci.*, vol. 41, pp. 312-215, 2017.

[13] Official Website of the Lagos State Government. *Lagos State*. 2018. https://lagosstate.gov.ng/about-lagos/

[14] National Bureau of Statistics (NBS). *Population Projection*. Demographic Statistics Bulletin, pp. 1-26, 2018.

[15] S. E. Hambolu, A. A. Dzikwi, J. K. P. Kwaga, H. M. Kazeem, J. U. Umoh, D.A. Hambolu, "Dog Ecology and Population Studies in Lagos State, Nigeria," *Glob J Health Sci.*, vol. 6, pp. 209-220, 2014.

[16] E.C. Faust, J.S. D'Antoni, V. Odom, M.J. Miller, C. Peres, W. Sawitz, "A critical study of clinical laboratory techniques for the diagnosis of protozoan cysts and helminth eggs in faeces. I. Preliminary communication," *Am J Trop Med Hyg*., vol. 18, no. S1, pp. 169-183, 1938.

[17] C. M. Hendrix, E. Robinson, "*Diagnostic Veterinary Parasitology for Technicians*," Fifth Edition, Elsevier Health Sciences, pp. 1-480, 2016.

[18] L. S. Garcia, G. W. Procop, "*Diagnostic Medical Parasitology*," Manual of Commercial Methods in Clinical Microbiology; 2016, pp. 284-308. Wiley Online Library.

[19] Food and Agricultural Organization (FAO). *Techniques for parasites assays and Identification in Faecal Samples.* The Epidemiology, Diagnosis and Control of Helminth Parasites of Ruminants. A Handbook. International Laboratory for Research on Animal Diseases Nairobi, Kenya, 1994.

[20] A. B. Ayinmode, O. O. Obebe, E. Olayemi, "Prevalence of potentially zoonotic gastrointestinal parasites in canine faeces in Ibadan, Nigeria," *Ghana Med J*., vol. 50, no. 4, 201-206, 2016.

[21] T. M. Tion, J. S. Ikurior, K. D. Orbunde, "The Prevalence of Gastrointestinal Helminths (GIH) Infection of Dogs in Makurdi Metropolis," *Imp J of Interdiscip Res*., vol. 2, no. 8, pp. 1042-1049, 2016.

[22] R. D. Robinson, D. L Thompson, J.F. Lindo, "A survey of intestinal helminths of well-cared-for dogs in Jamaica, and their potential public health significance," *J Helminthol*., vol. 63, pp. 32-38, 1989.

[23] R. C. Satyal, S. Manandhar, S. Dhakal, B.R. Mahato, S., "Chaulagain, L. Ghimire, Y.R. Pandeya. Prevalence of Gastrointestinal Zoonotic Helminths in Dogs of Kathmandu, Nepal," *Int J Infect Microbiol.*, vol. 2, no. 3, pp. 91-94, 2013.

[24] T. L. Mateus, A. Castro, J. N. Ribeiro, M., "Vieira-Pinto. Multiple Zoonotic Parasites Identified in Dog Feaces Collected in Ponte de Lima, Portugal-A Potential Threat to Human Health," *Int J Environ Res Public Health*, vol. 11, pp. 9050-9067, 2014.

[25] W. Rojekittikhun, K. Chaisiri, A. Mahittikorn, S. Pubampen, S. Sanguankiat, T. Kusolsuk, W. Maipanich, R. Udonsom, H. Mori, "Gastrointestinal Parasites of Dogs and Cats in a Refuge in Nakhon Nayok, Thailand," *SE Asian J Trop Med*., vol. 45, no. 1, pp. 31-39, 2014.

[26] O. W. Nyamongo, R. M. Nyarango, "Prevalence of Canid Gastrointestinal Helminths Eggs in Soils from Playgrounds within the Kisii Municipality, Kenya," *Res Rev J Zool Sci*., vol. 3, no. 1, pp. 27-31, 2015.

[27] M.F.M. Urgel, R.H.D. Ybañez, A. P. Ybañez, "The detection of gastrointestinal parasites in owned and shelter dogs in Cebu, Philippines," *Veterinary World*, vol. 3, no. 12, pp. 372-376. March 2019.

[28] Y. Mulugeta, M. Yohannes, D. Wolde, M. Aklilu, B. Ashenefe, D. Getahun, F. Lombamo, G. Kitila, G. Getahun, A. Deressa, H. Degefu, "Intestinal Parasites in Dogs and Humans, Environmental Egg Contamination and Risk of Human Infection with Zoonotic Helminth Parasites from Dog in Hosanna Town," *International Journal of Biomedical Materials Research*, vol. 7, no. 1, April, 2019, pp. 24-36.

[29] W. Kidima, "Prevalence of Zoonotic Parasites in Stray Dogs in Rural Communities, Tanzania." *Tanzania Journal of Science*, vol. 45, no. 1, pp. 93-100, 2019.

[30] F. L. Torre, A. D. Cesare, G. Simonato, R. Cassini, D. Traversa and A. F. di Regalbono, "Prevalence of zoonotic helminths in Italian house dogs." *Infect Dev Ctries*, vol. 12, no. 8, pp. 666-672, June, 2018.

[31] M. Beiromvand, A. Rafiei, E. Razmjou, S. Maraghi, "Multiple zoonotic helminth infections in domestic dogs in a rural area of Khuzestan Province in Iran." *BMC Veterinary Research*, vol. 14, no. 224, pp. 1-7, 2018.

[32] S. Lahmar, I. Arfa, B.S. Othmen, W. Jguirim, Y. Saïd, A. Dhibi, B. Boufana, "Intestinal helminths of stray dogs from Tunisia with special reference to zoonotic infections." *Parasitology Open*, vol. 3, no. e18, pp. 1-9, Nov., 2017.

[33] A. Geraili, Y. Maroufi, M. Dabirzadeh , H. Noormohammadi, S. M. Khoshsima, "Survey of gastrointestinal helminth of stray dogs in Zabol city, southeastern of Iran," *Arch of Razi Inst* 2016; vol. 71, no. 1, pp. 57-60, 2016.

[34] A. Daukšte, M. Kirjušina, A. Dzerkale, "Prevalence of Helmints in Dogs in Daugavpils Town (Latvia)," *Acta Biol. Univ. Daugavp*., vol. 2, no. 10, pp. 133-135, 2010.

[35] G. Gugsa, T. Hailu, S. Kalayou, N. Abebe, Y. Hagos, "Prevalence and Worm Burdens of Gastro-Intestinal Parasites in Stray Dogs of Mekelle City, Tigray, Ethiopia," *Am Eurasian J Agric Environ Sci*., vol. 15, no. 1, pp. 08-15, 2015.

[36] S. Das, M. A. Alim, S. Sikder, A. D Gupta, M. Masuduzzaman, "Prevalence and Worm Load of Enteric Helminthiasis in Stray Dogs of Chittagong Metropolitan, Bangladesh," *YYU Veteriner Fakultesi Dergisi*, vol. 23, no. 3, pp. 141-145, 2012.

[37] I. K. Idika, E. C. Onuoraha, C. F. Obia, P. U. Umeakuanac, C. O. Nwosua, D. N. Onaha, S. N. Chiejina, "Prevalence of gastrointestinal helminth infections of dog in Enugu State, South Eastern Nigeria," *Parasite Epidemiol Control*, vol. 2, 97-104, 2017.

[38] D. V. Ancy, D. Amala, "Identification of Man-made Disasters in Kerala Stray Dog Menace in Keral," *J Comput Biosci Eng*, vol. 2, pp. 1-3, 2015.

[39] E. Voslář˘ová, A. Passantino, "Stray Dog and Cat Laws and Enforcement in Czech Republic and in Italy," *Ann Ist Super Sanità*, vol. 148, no. 1, pp. 97-104, 2012.

[40] P. Prociv, J. Croese, "Human eosinophilic enteritis caused by dog hookworm Ancylostoma caninum," *Lancet*, vol. 8701, pp. 1299-302, 1990.

[41] M. Zhang, Y. Li, "Eosinophilic enteritis: a state-of-the-art review," *J Gastroenterol Hepatol*., vol. 32, pp. 64-72, 2017.

[42] J. Croese, A. Loukas, J. Opdebeeck, P. Prociv, "Occult enteric infection by Ancylostoma caninum: a previously unrecognized zoonosis," *Gastroenterol*., vol, 1, pp. 3-12, 1994.

[43] Centers for Disease Control and Prevention, "*Parasites-zoonotic Hookworm*," 1600 Clifton Road Atlanta, GA 30329-4027 USA. 2012.

[44] Center for Food Security and Public Health, "*Zoonotic Hookworms*," CFSPH, College of Veterinary Medicine, Iowa State University, Ames, Iowa 50011. 2013.

[45] K.O. Bandaranayaka, R.P.V.J. Rajapakse, R.S. Rajakaruna, "Potentially zoonotic gastrointestinal parasites of dogs in Lunugala Tea estate community in Central Sri Lanka," *Ceylon Journal of Science,* vol. 48, no.1, pp. 43-50, 2019.

[46] C. P. Molina, J. Ogburn, P. Adegboyega, "Infection by Dipylidium caninum in an infant," *Arch Pathol Lab Med*., vol. 127, pp. e157-e159, 2003.

[47] W. Page, J. A. Judd, R. S. Bradbury, "The Unique life cycle of Strongyloides stercoralis and Implications for public health action," *Trop. Med Infect. Dis*., vol. 3, pp. 1-11, 2018.

[48] Lagos Dog Law, Dog Law. Dog Law of the Federal and Lagos. Federal Republic of Nigeria Official Gazette. vol. 2, 1943.

[49] World Organization for Animal Health, "*Report on the OIE's International Standard on Stray Dog Population Control*," Guidance on the OIE's international standard on stray dog population control for APOs: Content, Implementation and Practical Impacts, Draft 12, pp. 1-49, 2015.

[50] I. Sternheim, "*Stray Dogs in the Netherlands: How Holland Became Free of Stray Dogs*," Dog Search, Animal Foundation Platform. Isis Publisher, Amsterdam, Netherlands, pp. 1-9, 2012.

[51] M. Bouwman, "*Animal Sheltering in the Netherlands*," Conference proceeding at the 6th National G2Z summit and workshops, themed: Reaching out to the community, 14th-19th September. Mantra on View Hotel, Gold Coast, pp. 1-5, 2015.