Original Article

The Intensity of Infection and Public Health Perception of Potentially Zoonotic Intestinal Parasites of Dogs in Kwara Central, Nigeria

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ABSTRACT

Background: The close relationship between dogs and humans and the possibility of intestinal parasite transmission from dogs to humans calls for frequent assessment of these potential zoonotic intestinal parasites in dogs and the possibility of their transmission to humans.

Objectives: This study aimed to determine the presence, intensity of infection, and public health perception of potentially zoonotic intestinal parasites in dogs of Kwara Central, Nigeria.

Methods: The study was conducted in 28 locations in Kwara Central Senatorial District of Kwara State, Nigeria. Three hundred and five healthy dogs were sampled. Two hundred and thirty respondents (dog owners or handlers) were questioned using a well-structured questionnaire containing open-ended and closed-ended questions. Fecal samples from the sampled dogs were subjected to the direct fecal smear technique, simple fecal centrifugation flotation technique, formalin-ethyl acetate concentration technique, and the modified Ziehl-Neelsen staining technique. Oocysts or eggs per gram of feces were counted using the modified McMaster technique.

Results: Seven different intestinal parasites (*Ancylostoma* spp., *Cryptosporidium* spp., *Dipylidium caninum, Isospora* spp., *Strongyloides stercoralis*, *Toxocara* spp., and *Uncinaria stenocephala*) were detected, with a prevalence ranging from 2.30% to 25.25%. Of these parasites, 6 were zoonotic. The mean intensities of infection were 91.43 eggs per gram (EPG) for *D. caninum*¸ 96.52 EPG for *S. stercoralis*, 129.36 ±28.12 oocysts per gram (OPG) for *Isospora* spp., 165.17±19.88 for *Toxocara* spp., 240.00±44.42 for EPG for *U. stenocephala*, and 303.64±31.83 EPG for *Ancylostoma* spp. Some dog owners and handlers were not cautious about possible zoonotic parasite transmission from dogs.

Conclusion: Zoonotic intestinal parasites of dogs are present and prevalent in Kwara Central, Nigeria. There is a need to educate the public on the possibility of zoonotic parasite transmission to humans.

Keywords: Dogs, Intestinal parasites, Nigeria, Public health, Zoonosis

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1. Introduction

Dogs (*Canis lupus familiaris*) are believed to have come a long way with man, as they are the most successful canid species in close association with humans worldwide (Ugbomoiko et al., 2008; Ola-Fadunsin et al., 2019a). Dogs are among the most important domestic animals in almost every human settlement globally (Shima et al., 2015). Recently, there has been an increase in the number of dogs in Nigeria, as individuals are now more interested in having dogs for various reasons, especially for security and breeding. This issue has increased the dog population in Nigeria by well above 5 million (Ola-Fadunsin, 2018). Dogs are kept for companionship as pets and are used for hunting, security, sports, life-saving actions, scientific research and therapeutic programs, combatting crime by the military and para-military organizations, and income generation through breeding and sale. In some ethnic groups, dogs are raised as a source of animal protein (Curi et al., 2017; Ola-Fadunsin, 2018; Mosallanejad et al., 2021; Yousef et al., 2022). As pets, they contribute to their owners' physical, social, emotional, and mental well-being, particularly children and aged people (Ola-Fadunsin et al., 2019a; Gouin et al., 2021). The close association between humans and dogs can lead to contamination of man's environment, hands, food, and water with infective oocysts of protozoans and eggs of helminths, which can lead to infections with serious consequences in humans (Taylor et al., 2016; Idika et al., 2017).

Intestinal parasites include protozoans and helminths in the intestinal tracts of animals and humans (Taylor et al., 2016). Intestinal parasites of dogs cause serious damage to the host and humans, and in some cases, they infect livestock and wildlife. They hinder the successful keeping of dogs and result in losses manifested by retarded growth, lowered resistance to infectious diseases, reduced work and feed efficiency, general ill health, and even death (Awoke et al., 2011; Abere et al., 2013). Among intestinal parasites of dogs, *Ancylostoma* species, *Cryptosporidium* species, *Giardia species*, and *Toxocara* species are important to public health (Sowemimo, 2009; Ngui et al., 2014; Ayan and Kilinç, 2020). These parasites are known to cause infections that are of great interest in most parts of the world, especially in developing countries and communities that may be socioeconomically challenged, where these parasites are responsible for some important zoonotic diseases (Robertson et al., 2000; Ngui et al., 2014).

The close relationship between dogs and humans and the possibility of intestinal parasite transmission from dogs to humans calls for frequent assessment of these potential zoonotic intestinal parasites in dogs. This study aimed to determine the presence, intensity of infection, and public health perception of potentially zoonotic intestinal parasites of dogs in Kwara Central, Nigeria.

2. Materials and Methods

Study location

This study was carried out in the Kwara Central Senatorial District of Kwara State, Nigeria. Kwara Central is the largest and most populous Senatorial District in Kwara State, and it covers Asa, Ilorin East, Ilorin South, and Ilorin West local government areas (Adam et al., 2022). An average of 10 dogs and 7 respondents (dog owners or handlers) were sampled and questioned from 28 randomly selected locations within Kwara Central of Kwara State (Figure 1). Global positioning system (GPS) coordinates from each location were recorded using the Financept® application.

Study design and sample collection

A cross-sectional study design was employed for this study. A total of 305 healthy dogs were sampled, and 230 respondents were questioned for this study.

Fecal samples were collected directly from the rectums of dogs (305 dogs in total) following proper restraint of the dogs.

Each fecal sample was collected into a well-labeled sterile sample bottle, put into an icebox, and transported to the Parasitology Laboratory of the Department of Veterinary Parasitology and Entomology, University of Ilorin, for further parasitological analyses. The collected samples were then stored in the refrigerator at +4ºC. All parasitological analyses were performed within 48 hours of sampling.

Information about the sampled dogs and the dog owners and handlers was obtained from the owners or dog keepers (230 in total) using a well-structured questionnaire containing open-ended and closed-ended questions.

Detection of intestinal parasites

Fecal samples were examined for the presence of protozoan oocysts and or helminth eggs. The direct fecal smear technique, simple fecal centrifugation flotation technique (using saturated NaCl solution), and the formalin-ethyl acetate (formol-ether) concentration technique were used to detect *Isospora* species and helminth parasites. These techniques were conducted as described by Cheesbrough

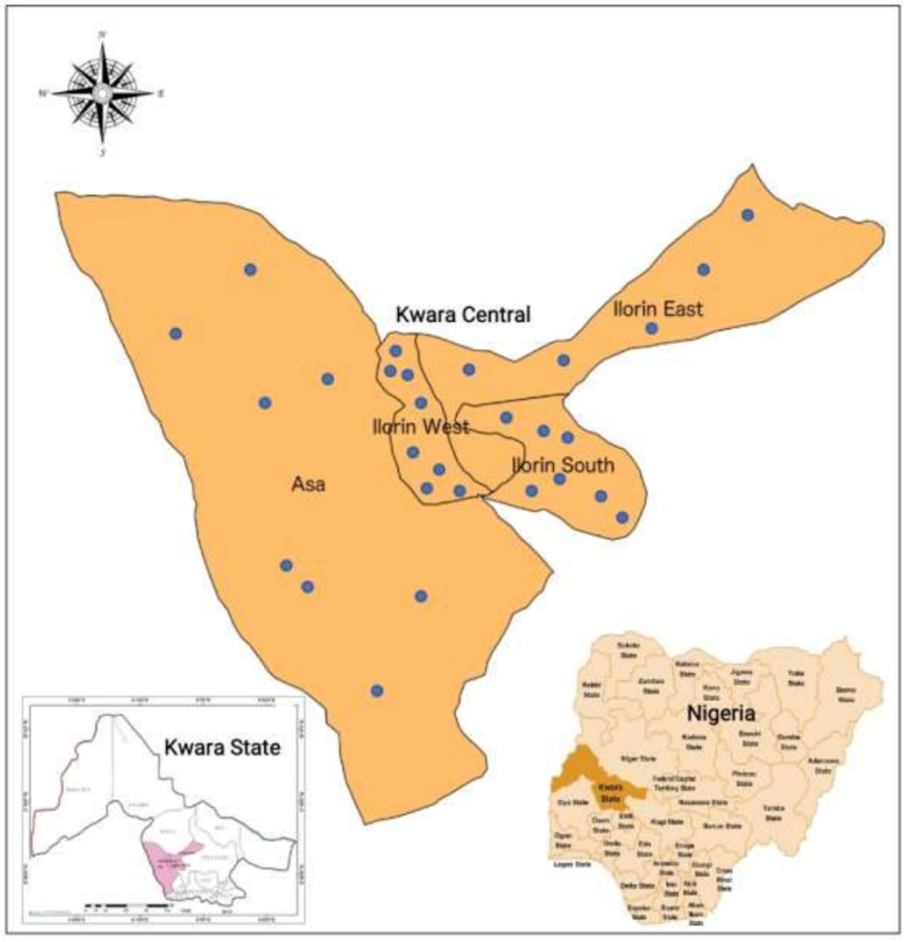

Figure 1. Map of Kwara Central, the study location (designed using QGIS version 2.6.1)

The insert map (on the left) shows Kwara Central within Kwara State (Onah et al., 2020). The insert map (on the right) shows Kwara State within Nigeria (Oladeji and Sule, 2015).

(2009) and Taylor et al. (2016). The modified Ziehl-Neelsen staining technique described by Cheesbrough (2009) was used to detect *Cryptosporidium* species. Sediments from the formol-ether concentration technique were used for the modified Ziehl-Neelsen stain. Oocysts of *Isospora* species and eggs of helminth species were counted using the modified McMaster technique with modifications as described by Ola-Fadunsin et al. (2019b).

Intestinal parasites were identified by using parasitological keys, as documented by Soulsby (1982), Foreyt (2001), and Taylor et al. (2016).

Parasite(s) positive fecal samples detected by one or more parasitological techniques were considered positive.

Data management and statistical analyses

The collected data for this study was initially recorded in a Microsoft Excel version 2016 spreadsheet. Afterward, the data were exported to the SPSS software, version 22.0 (SPSS, Chicago, Illinois, USA) for statistical analyses. Descriptive statistics were conducted to estimate the prevalence using percentages in charts and tables. The charts were created using Microsoft Excel version 2016. The prevalence was calculated as the fraction between the number of dogs positive for an intestinal parasite and the total number of dogs sampled, multiplied by 100. The Mean±SE, and 95% confidence interval (CI) were determined accordingly.

3. Results

Seven different intestinal parasites (5 helminths: 4 nematodes and 1 cestode, and 2 protozoans) were detected among dogs in the study area. The prevalence rates of these intestinal parasites were 2.30% (95% CI=1.12%–4.66%) for *D. caninum*, 6.89% for *U. stenocephala*, 7.54% (23/305) for *S. stercoralis*, 15.41% (95% CI=11.79%–19.89%) for *Isospora*

spp., 19.02% (58/305) for *Toxocara* spp., and 25.25% (95% CI=20.07%–30.41%) for *Ancylostoma* spp., and *Cryptosporidium* spp. *Ancylostoma* spp. had the highest intensity of infection with a Mean±SE EPG (eggs per gram of feces) of 303.64±31.83. This rate was followed by *U. stenocephala* with a Mean±SE EPG of 240.00±44.42. The least intensity of infection was observed in D. caninum (Mean±SE EPG of 91.43±7.38). The intensities of infection (measured in Mean±SE EPG) for the other parasites were 96.52±16.04 for *S. stercoralis*, 129.36±28.12 for *Isospora* spp., and 165.17±19.88 for *Toxocara* spp. (Table 1).

The prevalence of infection showed that 54.43% of the sampled dogs were infected with intestinal parasites. Of the infected dogs, 43.37% had single parasite infections, while 56.63% had mixed infections. Of the dogs with mixed infections, 55.32%, 36.17%, and 8.51% had two, three, and four parasitic infections, respectively (Figure 2).

A high number of respondents in the study area were over 25 years old (188/230, 81.74%), while more were male (56.96%; 95% CI=50.50%–63.19%). One hundred and thirty-six respondents knew about parasite transmission from animals to humans (59.13%; 95% CI=52.68%–65.28%), while 94 (40.87%; 95%=34.72%–47.32%) were ignorant of possible parasitic zoonosis. Most respondents (73.91%; 95% CI=67.88%–79.16%) and their children (39.57%; 95% CI=33.47%–46.01%) were very close to their dogs. Two hundred and twenty-three of the respondents (96.96%; 95% CI=93.85%–98.52%) wash their hands after coming in contact with dog feces, while seven do not (3.04%; 95% CI=1.48%–6.15%). Of those that wash their hands, 8(3.59%) wash their hands with water alone, 181(81.17%) use water and soap, 23(10.31%) wash with water and soap and use hand sanitizer, and 11(4.93%) wash their hands with water and use hand sanitizer afterward. About 67% (153/230) of the respondents allow their children to play with dogs, while 33.48% (77/230) do not. Of those that allow their children to play with dogs, 78(50.98%; 95% CI=43.13%–58.78%) wash the hands of their children after playing with dogs, while 75 (49.02%; 95% CI=41.22%–56.87%) do not. Fifty-two of the respondents (22.61%; 95% CI=17.68%–28.44%) allow their children to play in areas where dogs defecate, while 178(77.39%; 95% CI=71.56%–82.32%) do not. About 13% (21/230; 95% CI=8.69%–19.12%) of the respondents treat their dogs monthly against parasitic infections, while 11.18% (18/230; 95% CI=7.19–16.98) and 75.78% (122/230; 95% CI=68.61–81.74) treat their dogs quarterly and yearly, respectively, against parasitic infections (Table 2). Other results of dog management practices among dog owners are presented in Table 2.

4. Discussion

Ancylostoma spp., *Cryptosporidium* spp., *D. caninum*, *Isospora* spp., *S. stercoralis*, *Toxocara* spp., and *U. stenocephala* were the intestinal parasites detected, with most of them (6) having zoonotic potential (Taylor et al., 2016). Zoonosis of parasitic origin has become a great challenge in many world countries (Cavallero et al., 2021). The detection of more helminth parasites than protozoan parasites among dogs in this study could be attributed to the fact that helminth ova (eggs) can survive better in the environment and are more effectively transmitted to dogs than protozoan oocysts (Ayinmode et al., 2016).

Table 1. Prevalence and mean intensity of intestinal parasites infection among dogs in Kwara Central Nigeria (n=305)

Parasites	No.	Prevalence (%)	95% CI	EPG/OPG
				Mean±SE
Ancylostoma spp.	77	25.25	20.07–30.41	303.64±31.83
Toxocara spp.	58	19.02	15.01–23.80	165.17±19.88
Strongyloides stercoralis	23	7.54	5.08–11.06	96.52±16.04
Uncinaria stenocephala	21	6.89	4.55–10.30	240.00±44.42
Dipylidium caninum	7	2.30	1.12–4.66	91.43±7.38
Isospora spp.	47	15.41	11.79–19.89	129.36±28.12
Cryptosporidium spp.	77	25.25	20.07–30.41	X

Abbreviations: EPG: Egg per gram; OPG: Oocyst per gram; SEM: Standard error of the mean; X: Not applicable.

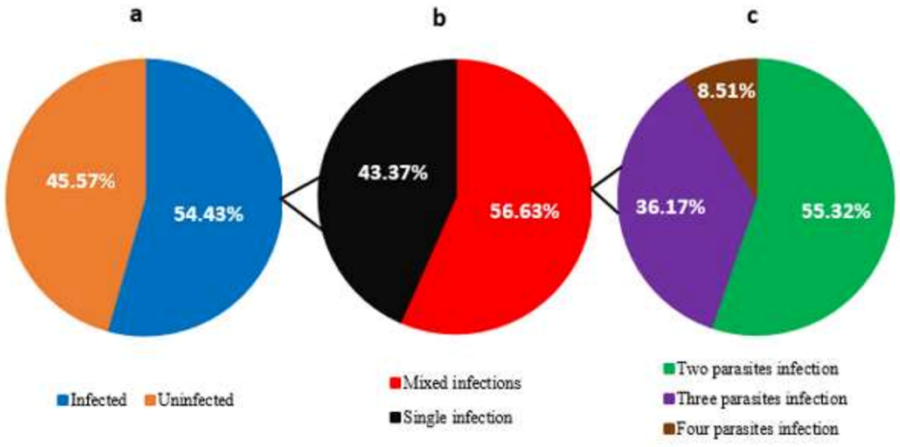

Figure 2. The prevalence rates of infections

A) Between infected and uninfected groups, B) between mixed and single infection categories of the infected group, C) The different categories within the mixed infection group.

Table 2. Sociodemographic profile, knowledge of zoonosis, level of hygiene, and dog management practices of respondents in Kwara Central, Nigeria (n=230)

Variables	Category	Proportion (%)	95% CI
Age of respondents (y)	<25	42(18.26)	13.80–23.76
	≥25	188(81.74)	76.24–86.20
Gender of respondents	Male	131(56.96)	50.50–63.19
	Female	99(43.04)	36.81–49.5
Do you know about zoonotic parasites?	Yes	136(59.13)	52.68–65.28
	No	94(40.87)	34.72–47.32
How close are you to your dog?	Not close	27(11.74)	8.20–16.54
	Close	33(14.35)	10.40–19.46
	Very close	170(73.91)	67.88–79.16
How close are your children to dogs?	Not close	62(26.96)	21.64–33.03
	Close	77(33.48)	27.70–39.80
	Very close	91(39.57)	33.47–46.01
Do you wash your hand after coming in contact with dog feces?	Yes	223(96.96)	93.85–98.52
	No	7(3.04)	1.48–6.15
What do you use to wash your hand after coming in contact with dog feces?	Water alone	8(3.59)	1.83–6.92
	W+S	181(81.17)	75.52–85.75
	W+S+HS	23(10.31)	6.97–15.00
	W+HS	11(4.93)	2.78–8.62
Do your children play with dogs?	Yes	153(66.52)	60.20–72.30
	No	77(33.48)	27.70–39.80

Variables	Category	Proportion (%)	95% CI
Do you wash the hands of your children after playing with dogs?	Yes	78(50.98)	43.13–58.78
	No	75(49.02)	41.22–56.87
Do your children play in areas where dogs defecate?	Yes	52(22.61)	17.68–28.44
	No	178(77.39)	71.56–82.32
How many dogs do you have?	One	5(2.17)	0.93–4.99
	More than one	225(97.83)	95.01–99.07
How is your dog housed?	Caged	104(45.22)	38.92–51.68
	Roam	121(52.61)	46.17–58.97
	Caged/Roam	5(2.17)	0.93–4.99
Do you dispose of your dog's feces?	Yes	179(77.83)	72.03–82.71
	No	51(22.17)	17.29–27.97
How often do you dispose of your dog's feces?	Daily	104(58.10)	50.78–65.08
	Every 2 days	72(40.22)	33.32–47.54
	Weekly	3(1.68)	0.57–4.81
Do you treat your dogs against parasites?	Yes	161(70.00)	63.79–75.55
	No	69(30.00)	24.45–36.21
What frequency of antiparasitic treatment(s) is given to your dogs?	Monthly	21(13.04)	8.69–19.12
	Quarterly	18(11.18)	7.19–16.98
	Yearly	122(75.78)	68.61–81.74

Abbreviations: W: Water; S: Soap; HS: Hand sanitizer

Ancylostoma species of dogs include *Ancylostoma braziliense*, *A. caninum,* and *A. ceylanicum* (Taylor et al., 2016); these are zoonotic hookworms that cause cutaneous larva migrans and eosinophilic enteritis in infected humans (Prociv and Croese, 1990; Bowman et al., 2010).

Cryptosporidium canis is the major causative agent of cryptosporidiosis in dogs. However, *C. meleagridis*, *C. muris*, and *C. parvum* have also been reported in dogs (Ayinmode et al., 2018). These protozoan species have been implicated in causing diarrhea and even death in humans (Uehlinger et al., 2013).

Human infections with *D. caninum* are not common. However, it is more likely to infect young children who kiss or are licked by infected dogs or cats. This condition is associated with mild diarrhea in infected individuals (Jiang et al., 2017).

Strongyloides stercoralis is a soil-transmitted helminth in humans. It causes different symptoms in humans ranging from dermatologic manifestations such as localized edema or urticaria to gastrointestinal manifestations such as abdominal pain, constipation, diarrhea, intermittent vomiting, and duodenal obstruction. It also exhibits cardiopulmonary and central nervous system manifestations (Nutman, 2017). It is estimated to infect about 100 million people worldwide (Schar et al., 2013).

Toxocara canis is the major etiology of canine *toxocariasis*. Nevertheless, *T. leonina* can infect dogs (Oguz et al., 2018). *Toxocara canis* is responsible for visceral and ocular larva migrans, neurotoxocariasis, and common toxocariasis in humans (Chen et al., 2018). *Uncinaria stenocephala*, like *A. caninum*, causes cutaneous larva migrans and eosinophilic enteritis in humans (Bowman et al., 2010; Ayinmode et al., 2016).

The high prevalence of *Ancylostoma* spp., *Cryptosporidium* spp., and *Toxocara* spp. detected in the feces of sampled dogs recapitulates previous reports in Nigeria (Ayinmode et al., 2016; Ezema et al., 2019; Kamani et al., 2021) and outside Nigeria (Abere et al., 2013; Ngui et al., 2014; Torres-Chablé et al., 2015). The prevalence rates of 33.24%, 36.45%, and 41.67% for *Ancylostoma* spp., *Cryptosporidium* spp., and *Toxocara* spp., respectively, have been reported among dogs in Nigeria (Ugbomoiko et al., 2008; Idika et al., 2017; Eze et al., 2019). In countries outside Nigeria, the prevalence rates of 33.04%, 33.46%, and 64.71% for *Ancylostoma* spp., *Toxocara* spp., and *Cryptosporidium* spp., respectively, have been reported among dogs (Bahrami et al., 2011; Ayan and Kilinç, 2020; Ilic et al., 2021). The high intensity of *Ancylostoma* spp. and *Toxocara* spp. eggs detected in dog feces may be associated with the high fecundity of these helminths (Taylor et al., 2016), which translates to an increased number of eggs passed in feces.

The presence of mixed infections with more than one parasite at the same time is very common in animals, including dogs (Viney and Graham, 2013; Ola-Fadunsin et al., 2019a), which is the reason more of the infected dogs had mixed parasitic infections. Mixed infections of *Ancylostoma* spp., *Toxocara* spp., and *D. caninum* was reported among dogs in Nigeria (Idika et al., 2017), while co-infections of *Ancylostoma* spp., *Toxocara* spp., and *Isospora* spp. has been documented among dogs in Malaysia (Ngui et al., 2014).

The absence of documented cases of canine zoonotic parasitic infections among humans in the study area could be attributed to the fact that more respondents are knowledgeable about the possible transmission of parasites from dogs to humans. The hygiene level of dog owners and handlers after coming in contact with dogs, the level of closeness between dogs and their owners together with their children, and the level of the management practices of dog owners and handlers could predispose to the possibility of canine parasitic infections in humans in the study area. The low frequency of intestinal parasite control by dog owners does not guarantee adequate protection of dogs against parasitic infections (Alho et al., 2018), which could have contributed to the high prevalence of intestinal parasites recorded in this study.

5. Conclusion

In conclusion, the high prevalence and number of potentially zoonotic intestinal parasites detected among dogs and the level of hygiene and dog management practices by dog owners and handlers in Kwara Central, Nigeria, pose a possible risk to human health with regard to zoonotic infections. Therefore, it is necessary to educate dog owners and handlers on the need to regularly treat their dogs against intestinal parasites and to improve their personal hygiene to control parasitic infections among dogs and prevent possible zoonotic infections in humans, respectively.

Ethical Considerations

Compliance with ethical guidelines

Permission to conduct this study was granted by the Research and Ethics Committee of the Faculty of Veterinary Medicine, University of Ilorin, Nigeria, with the protocol number FVER/017/2021. All samples were collected using standard sample collection methods without inflicting pain or harm on the dogs. Consent was sought and was willingly granted by the dog owners or handlers before filling out questionnaires and their dogs being sampled for the study.

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Authors' contributions

Conceptualization, supervision: Shola David Ola-Fadunsin; Methodology: Shola David Ola-Fadunsin, Isau Aremu Ganiyu, Karimat Hussain, and Nusirat Elelu; Investigation and writing-original draft: Shola David Ola-Fadunsin and Aminat Bisola Abdulrauf; Writing–review & editing: All authors; Data collection: Shola David Ola-Fadunsin, Aminat Bisola Abdulrauf, Isau Aremu Ganiyu, and Hauwa Motunrayo Ambali; Data analyses: Shola David Ola-Fadunsin and Aminat Bisola Abdulrauf; Funding acquisition and Resources: All authors.

Conflict of interest

The authors declared no conflict of interest.

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