Prevalence of Babesia Spp. in Presumably Healthy Dogs and Associated Risk Factors in OBIO/AKPOR Local Government Area, Rivers State, Nigeria

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ABSTRACT

Babesia canis is a parasitic protozoan transmitted by Ixodid ticks. It infects the red blood cells of most mammals especially dogs, causing canine babesiosis. In the present study, the prevalence of Babesia spp. and associated risk factors among dogs in Obio/Akpor Local Government Area, Rivers State were investigated using blood film. Blood samples from 150 dogs were randomly collected and examined for the presence of the parasite with March and November, 2022. Blood films were prepared, fixed in methanol, stained in Giemsa and examined under the microscope for the presence of the parasite. Data on age, breed, sex and other related risk factors were obtained using self-structured questionnaire. Out of the 150 dogs examined, 27(18%) were infected and out of the 27 infected dogs, 3(11.1%), 10(37.0%), 2(7.4%), 6(22.2%), 2(7.4%) and 4(14.8%) were from Rumuolumeni, Ogbogoro, Rumuopirikon, Choba, Rumuola and Ozuaba communities respectively. There was a significance difference (p<0.05) in the number of infected dogs across the communities when compared to the number of dogs that were not infected. More males 12(19.4%) were infected than females 6(14.3%). Dogs within the age range of 7-36months had the highest infection 16(59.3%) while no infection was recorded among dogs within the age group of 3-6months. Local breed had the highest infection 18(36%) than crossed breed6(12%) and exotic breed 3(6%). There was a significance difference (p<0.05) in the prevalence of Babesia spp. in relation to sex, agePp and breed of dogs. Other risk factors identified were management practice, vaccination, use of dogs and intensity of tick infestation which were all statistically significance (p<0.05). The study confirmed that canine babesiosis is a serious health concern among dogs in the study area and attention should be given to the risk factors during intervention.

Keywords: Babesia, Obio/Akpor, Nigeria, Prevalence, Tick

INTRODUCTION

Dogs are one of the most important domesticated animals in many parts of the globe where they are used for security, hunting and as pets (Omudu et al. 2007). In Africa, dogs are kept for similar purposes including breeding, herding and source of protein (Opera et al. 2005; Hambolu et al., 2014) and for the treatment of certain illness (Gurumyen et al., 2020). Incidentally, dogs are one of the many targets of Babesia spp. especially because they are vulnerable to tick infestation (Omudu et al. 2007; Solano-Gallego et al., 2016). The parasites infect a wide range of both domestic and wide animals including man (Carter, 2001; Schnitger et al., 2012).

Babesia canis is a tick-borne parasitic protozoan with global distribution (Otranto et al., 2009). It has been reported in Mexico (Lira-Amaya et al. 2017), Argentina (Mascarelli et al. 2016), Chile (Dicataldo et al. 2020), Peru (Temoche et al. 2018), Colombia (Galvan et al. 2018), Brazil (de Sousa et al. 2018), Costa Rica (Wei et al. 2015), Poland (Dwuznik-Szarek et al. 2022), United State (Birkenheuer et al. 2004), Europe (Caccio et al. 2002; Beck et al. 2009; Carcy et al. 2015; Rene et al. 2012), Zambia (Naluhamb et al. 2015), Tanzania (Bloch et al. 2018), Kenya (Githaka et al. 2022) and Nigeria (Omudu et al. 2007; Jegede et al. 2014; Obeta et al. 2020). The parasite belongs to the genus Babesia and, alongside other species of the genus, are responsible for babesiosis in dogs, horses and rodents (Oguche et al. 2020). There are two groups of Babesia: the large and small Babesia. Babesia canis is a large form. They can be morphologically differentiated by
their size and shape in the infected red blood cell (Laha et al., 2015). The large forms with pyriform shape is pointed at one end and round at the other) orientate in the red blood cell in acute angle to each other while the small forms (oval shape lacking pyriform) lies at an obtuse angle to each other (Ruprah, 1985; Laha et al., 2015). Other members of the genus include Babesia rossi, Babesia vogeli, Babesia gibsoni and Babesia microti (Jegede et al., 2014; Nalubamba et al., 2015; Rene-Marlelet et al., 2015; Obeta et al., 2020). These species, except Babesia microti have been reported in Africa (Solano-Gallego and Baneth, 2011).

*Babesia canis* causes canine babesiosis also known as malignant jaundice (Penzhorn et al., 2017) or piroplasms (Irwin, 2009). The parasite dwells in the red blood cells where it replicates and destroy the erythrocytes causing disease to the host. The commonest mode of spreading the infection is through tick bite during blood meal (Jegede et al., 2014; Nalumanba et al., 2015). Transmission through blood transfusion and transplacental transmission have also been reported (Jegede et al., 2014).

Hard ticks are the major vectors of babesiosis. *Dermacentor ricultations* transmits *B. canis* in Europe (Barker et al., 2012), *Rhipicephalus sanguineus* transmits *B. vogeli* in tropical and sub-tropical regions of the world (Lavan et al., 2018), including Asia, North America, North and East Africa (Hauschild et al., 1995; Oguche et al., 2020) but in South Africa, *B. rossi*, which causes a fatal in infection in dogs is transmitted by *Haemaphysalis sanguineus* (Bashir et al., 2009; Avenant et al., 2021). The pathological presentation and severity of the infection is dependent on the species of *Babesia* responsible for the infection and the host immune response (De Tomman et al., 2013). However, the general manifestation may include anaemia, lymphopenia, neutropenia and thrombocytopenia (Mathe et al., 2006). Other symptoms include weakness, jaundice, pallor, hypotoxic injury, systemic inflammation fever, splenomegaly and collapse resulting from intra and extra vascular hemolysis (Irwin, 2009; Oguche et al., 2020). In humans, infection by canine babesiosis can results in serious diseases condition especially in immune-compromised persons (Salano-Gallego et al., 2016) but may present slight symptoms in immune-competent individuals (Vannier and Kraus, 2012; Yabsley and Shock, 2013).

Although several reports of Babesiosis have been documented in Nigeria since its emergence in 1962 (Obeta et al., 2020), scanty record exist on the prevalence of canine babesiosis among dogs in Rivers State particularly in Obio/Akpor Local Government Area. This study is therefore aimed at the determination of the prevalence and associated risk factors of the infection among dogs in some communities of Obio/Akpor Local Government Area.

**MATERIALS AND METHODS**

The study was conducted in Obio/Akpor Local Government Area of Rivers State, Nigeria. The Local Government area is located in the Niger Delta and lies along the Bonny River with an estimated population of 3,171,076 inhabitants (Demographia, 2021). It covers an area of about 369Km² and lies on latitude 4°49′27″N longitude 7°2′1″E, with an average temperature and humidity of 22°C and 90% respectively. The LGA is above sea level and it is characterised a tropical climate as in other cities of the Niger Delta. Rainfall is significant most months of the year, and the short dry season has little effect. Six communities within the LGA were randomly selected for this study. The communities were Rumuolumeni (4°48′21″N, 6°56′37″E), Ogbogoro (4°52′27″N, 7°56′30″E), Rumuepirikom (4°54′4″N, 6°58′15″E), Rumuola (4°50′7″N, 7°0′1″E), Ozuoba (4°51′4″N, 6°58′51″E) and Choba (4°54′4″N, 6°57′49″E) respectively (Fig. 1).

![Fig. 1.0: Map of study area](image)

**Sample size**

The sample size for this study was determined using the method of Kothari (2004).

\[
S = \frac{N}{1 + N(e^2)}
\]

Where:

- **S** = Sample size
- **N** = Population size under the study which is the total number of dog population officially registered by the veterinary unit of Ministry of Agriculture in Obio/Akpor Local Government Area.
- **a** = Level of significance, which is 0.05

\[
S = \frac{240}{1 + 240 (0.05)^2}
\]
Therefore, a total of 150 dogs (25 dogs from each of the communities) were randomly selected for this study. The communities were Rumuolumeni, Ogbogoro, Rumuepirikom, Rumuola, Ozuoba and Choba.

Sample collection
A total of 150 dogs (50 local breed, 50 exotic breed and 50 cross breed) were randomly selected for investigation for the presence of *Babesia canis* infection in the study area. Blood samples from these dogs were obtained the help of a veterinary doctor and the owners. The method of WHO, (1991) which was adopted in the collection of blood samples. About 10ml of blood sample was collected through the cephalic vein using 5mL disposable syringe and 23-gauge needle into a sample vial containing 1mg ethylene di-amine tetra acetate-K (EDTA-K) as anticoagulant. The blood samples were immediately kept inside a cool box containing icepack and transported within 4 hours to the Research Laboratory, Department of Biology, Ignatius Ajuru University of Education, for parasitological examination.

Parasitological analysis of blood samples
Laboratory examination of the blood samples for the presence of *Babesia canis* were done using the method of Hendrix and Robinson (2006). Thin blood smears were prepared from the blood samples, air dried and fixed in methanol for 3-5 minutes and allowed to dry. The slides were stained in 3% Giemsa for 30 minutes and washed with phosphate buffered saline (PBS) to remove excess stains. The slides were then air-dried and examined under oil immersion (x100) for presence of intra-erythrocytic merozoites of *Babesia spp.*

Questionnaires
A total of 150 copies of self-structured questionnaires were produced and distributed to the dog owners to obtain information regarding the sample location, sex, age, breed, management and infestation of ticks as well as the risk factors associated.

Data analysis
The data collected was analyzed using SPSS version 20 to determine the prevalence while Chi-square was used to evaluate the relationship between the variables including age, sex, breed and risk factors. Value of *P*<0.05 was considered significant and confidence interval of 95%. The following formulae were used to determine the prevalence in relation to the respective variables.

(i) Overall prevalence of *Babesia canis* (OP) = \[ \frac{\text{Total number of dogs infected}}{\text{Total number of dogs examined}} \times 100 \]

(ii) Prevalence of *Babesia canis* in relation to sex = \[ \frac{\text{Total number of infected dogs per sex}}{\text{Total number of dogs examined per sex}} \times 100 \]

(iii) Prevalence of *Babesia canis* infection in relation to age of dogs = \[ \frac{\text{Total number of infected dogs per age}}{\text{Total number of dogs examined per age}} \times 100 \]

(iv) Prevalence of *Babesia canis* infection in relation to breed of the dogs = \[ \frac{\text{Total number of dogs infected per breed}}{\text{Total number of dogs examined per breed}} \times 100 \]

(v) Evaluation of potential risk factors = \[ \frac{\text{Total number of respondents per each potential risk factor}}{\text{Total number of respondents}} \times 100 \]

Ethical Clearance
The ethical clearance for this study was obtained from the Rivers State Ministry of Agriculture, Port Harcourt, Directorate of Research and Development, Ignatius Ajuru University of Education while verbal consent obtained from dog owners.

RESULTS
Overall Prevalence of *Babesia canis* in dogs
Blood samples from a total of 150 dogs were examined for the presence of *Babesia canis*, out of which 27 (18%) were positive for the parasite. Out of the 27 infected dogs, 3 (11.1%), 10 (37.0%), 2 (7.4%), 6 (22.2%), 2 (7.4%) and 4 (14.8%) were from Rumuolumeni, Ogbogoro, Rumuola, Ozuoba and Choba, Rumuolumeni and Ozuoba communities respectively (Table 1). The parasites were identified as pear-shape bodies in red blood cells examined under the microscope (Plate 1).

![Plate 1: Merozoite (Giemsa Stained) of Babesia canis in infected red blood cell](image-url)
Table 1: Overall prevalence of Babesia canis infection among dogs in Obio/Akpor

<table>
<thead>
<tr>
<th>Locations</th>
<th>No. of dogs Examined</th>
<th>No. Positive (%)</th>
<th>P-Value P&lt;0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rumuolumeni</td>
<td>25</td>
<td>3 (11.1)</td>
<td>0.000002</td>
</tr>
<tr>
<td>Ogbogoro</td>
<td>25</td>
<td>10 (37.0)</td>
<td></td>
</tr>
<tr>
<td>Rumuepirikom</td>
<td>25</td>
<td>2(7.4)</td>
<td></td>
</tr>
<tr>
<td>Choba</td>
<td>25</td>
<td>6(22.2)</td>
<td></td>
</tr>
<tr>
<td>Rumuola</td>
<td>25</td>
<td>2(7.4)</td>
<td></td>
</tr>
<tr>
<td>Ozuoba</td>
<td>25</td>
<td>4(14.8)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>150</td>
<td>27(18)</td>
<td></td>
</tr>
</tbody>
</table>

Prevalence of Babesia spp. in relation to sex, age and breed of dogs

A total of 150 dogs (108 males and 42 females) were examined. Out of the 108 males and 42 females examined, 21 (19.4%) and 6 (14.3%) were positive for the parasite respectively (Table 2). Similarly, all the 150 dogs investigated were within the age of 3-60 months. A total of 42, 71 and 37 dogs were within the age group of 3-6 months, 7-36 months and 37-60 months respectively. The results indicates that out of the 42 dogs within the age range of 3-6 month examined, there was no infection 42 (0%), of the 71 dogs within the age range of 7-36 months, 16 (22.5%) were positive while out of the 37 dogs in the age group of 37-60 months examined, 11 (29.7%) were infected (Table 2). Out of the 150 dogs examined, 50 each were local, exotic and crossed breeds. Local breed had the highest numerical infection 18 (36%), followed by crossed breed 6 (12%) and exotic breed 3 (6%). There was no significance difference (p>0.05) in the prevalence of the infection in relation to sex, age and breed of dogs investigated.

Table 2: Prevalence of Babesia canis infection in relation to sex, age and breed of dogs

<table>
<thead>
<tr>
<th>Variables</th>
<th>No. examined</th>
<th>No. Infected (%)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td>4.60</td>
</tr>
<tr>
<td>Male</td>
<td>108</td>
<td>21 (19.4)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>42</td>
<td>6 (14.3)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>150</td>
<td>27 (18)</td>
<td></td>
</tr>
<tr>
<td>Age (Months)</td>
<td></td>
<td></td>
<td>1.08</td>
</tr>
<tr>
<td>3-6</td>
<td>42</td>
<td>0 (0)</td>
<td></td>
</tr>
<tr>
<td>7-36</td>
<td>71</td>
<td>16 (59.3)</td>
<td></td>
</tr>
<tr>
<td>37-60</td>
<td>37</td>
<td>11 (40.7)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>150</td>
<td>27(18)</td>
<td></td>
</tr>
<tr>
<td>Breed</td>
<td></td>
<td></td>
<td>1.96</td>
</tr>
<tr>
<td>Local</td>
<td>50</td>
<td>18(36)</td>
<td></td>
</tr>
<tr>
<td>Exotic</td>
<td>50</td>
<td>3(6)</td>
<td></td>
</tr>
<tr>
<td>Crossed</td>
<td>50</td>
<td>6(12)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>150</td>
<td>27(18)</td>
<td></td>
</tr>
</tbody>
</table>

Prevalence of Babesia spp. in relation to risk factors

A total of 150 questionnaires containing self-structured questions were produced and distributed to dog owners with the view to evaluating certain risk factors associated with babesiosis. Out of the 150 respondents, 88 and 62 agreed that they keep stray dogs and caged dogs respectively. Of the 88 stray dogs, 18(66.7%) were infected while 9(33.3%) of the caged dogs were positive for babesiosis (Table 3). Similarly, 21(77.8%) of dogs that had tick infestation and 6(22.2%) of dogs that had no tick were positive for the infection respectively. A total of 54 dogs were regularly vaccinated, out of which 2(7.4%) were infected while 25(92.6%) of the 96 dogs that had no regular vaccination were positive for babesiosis (Table 3).

Table 3: Risk factors associated with the transmission of Babesia canis (n =150).

<table>
<thead>
<tr>
<th>Variables</th>
<th>No. of respondents (dog owners)</th>
<th>No. of dogs infected (%)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management Method</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>adopted</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dogs are not confined</td>
<td>88</td>
<td>18 (66.7)</td>
<td>0.002</td>
</tr>
<tr>
<td>(Stray dogs)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dogs are confined</td>
<td>62</td>
<td>9 (33.3)</td>
<td></td>
</tr>
<tr>
<td>(Caged dogs)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>150</td>
<td>27 (18)</td>
<td></td>
</tr>
<tr>
<td>Tick infestation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presence of tick</td>
<td>56</td>
<td>21 (77.8)</td>
<td>0.002</td>
</tr>
<tr>
<td>Absence of tick</td>
<td>94</td>
<td>6 (22.2)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>150</td>
<td>27 (18)</td>
<td></td>
</tr>
<tr>
<td>Vaccination</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular</td>
<td>54</td>
<td>2 (7.4)</td>
<td>0.04</td>
</tr>
<tr>
<td>Not regular</td>
<td>96</td>
<td>25 (92.6)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>150</td>
<td>27 (18)</td>
<td></td>
</tr>
<tr>
<td>Reason for keeping dog</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pet</td>
<td>36</td>
<td>2 (7.4)</td>
<td>0.02</td>
</tr>
<tr>
<td>Hunting</td>
<td>44</td>
<td>16 (59.3)</td>
<td></td>
</tr>
<tr>
<td>Security</td>
<td>70</td>
<td>9 (33.3)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>150</td>
<td>27 (18)</td>
<td></td>
</tr>
<tr>
<td>Area</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>75</td>
<td>19 (70.4)</td>
<td>0.013</td>
</tr>
<tr>
<td>urban</td>
<td>75</td>
<td>8(29.6)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>150</td>
<td>27(18)</td>
<td></td>
</tr>
<tr>
<td>Diet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pet food</td>
<td>47</td>
<td>7(26.0)</td>
<td>0.006</td>
</tr>
<tr>
<td>Home-made food</td>
<td>64</td>
<td>10(37.0)</td>
<td></td>
</tr>
<tr>
<td>Anything</td>
<td>39</td>
<td>10(37.0)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>150</td>
<td>27(18)</td>
<td></td>
</tr>
</tbody>
</table>

Out of the 36, 44 and 70 dogs kept as pet, hunter and security respectively, 7(26%), 10(37%) and 10(37%) were positive for babesiosis respectively (Table 3). More rural dogs (70.4%) were infected than
urban dogs (29.6%). The infection rate of dogs that were fed on home-made food was 37%, dogs that ate anything had 37% infection rate while dogs that were fed on pet food had 26% (Table 3). The results indicated that these factors significantly (p<0.05) influence the prevalence of the infection.

**DISCUSSION**

*Babesia canis* is a haemoparasite that causes canine babesiosis in dogs. The infection is highly pathogenic and is the major cause of haemolytic anaemia in dogs in the tropics (Kamani et al., 2011). The parasite is among the most widely distributed haemoparasites of dogs occurring in almost anywhere the tick vector *Rhipicephalus sanguineus* is reported (Taylor et al., 2007).

This study recorded a high overall prevalence of 27% of *Babesia canis* in the study area. This is an indication that babesiosis is still a health challenge in the area and that the tick-vector of the parasite is widely distributed in Nigeria. The recorded prevalence is higher than the 8.9%, 11.66% and 10.8% reported in Abuja at various times by Jegede et al., 2014, Obete et al., 2009 and Obeta et al., 2020 respectively. It is also higher than the 10.2% and 12.9% recorded in Makurdi and Plateau State by Amuta et al. (2010) and Oguche et al. (2020) respectively; as well as the 2.4%, 3.8%, 5.3% and 13.33% in Zambia, Cape Verde, Southern France and Costa Rica by Williams et al. (2014), Salem and Farag (2014), Garcia-Quesada et al. (2021) and Rene-Martellet et al. (2015) respectively. The differences in the prevalence recorded in the various studies may be attributed to the poor management strategies adopted by the dog owners (Obeta et al., 2020), relative distribution and abundance of the tick-vector of the parasite, differences in geography of study areas (Jegede et al., 2014) and lack of immunization of the dogs by their owners (Amuta et al., 2010).

In this study, more males were infected than females and this was statistically significant (p<0.05) (p-value=?). This is in consonance with previous studies in Jos, Nigeria by Omudu et al. (2007), in Vom, Northern Nigeria by Daniel et al. (2016) and elsewhere in South Africa by Mellanby et al. (2011). The high prevalence could be as a result of the hormonal status of the male dogs particularly the presence of testosterone which might limit the quality of care given to it by the owner, excessive roaming behaviours of male dogs to search for mating partners and establish territories, exposing them to more tick infestation (Mellanby et al., 2011, Daniel et al., 2016; Obeta et al., 2020). Their female counterparts are presumably less mobile as they spend much time nursing the puppies and are giving good care and attention by the owners due to their economic value. The result is however contrary to the records of Omudu et al. (2010) in Makurdi, Okunbanjo et al. (2013) in Abuja, Jedege et al. (2014) in Abuja and Oguche et al. (2020) in Jos. These studies recorded high prevalence of *B. canis* in female more than male dogs.

The study recorded a high infection rate (p<0.05) (p-value=?) of *Babesia* spp. in older dogs while there was no observable infection in younger dogs. Specifically, dogs within the age range of 7-36 months had the highest infection. This is in agreement with previous studies by Obeta et al. (2020) and Jegede et al. (2014) who reported a high prevalence of the parasite in older dogs in Abuja. Similar observation was made in Jos by Oguche et al. (2020). This result contradicts the report of Okunbanjo et al. (2013) who observed a low prevalence of the parasite in older dogs and a high prevalence in puppies in Zaria. The relatively high prevalent rate recorded in this study could be attributed to lower resistant and poor immune system against the parasite by older dogs, possibly because of age. Research indicates that animal immunity decreases with age making them susceptible to infection. It may also be attributed to frequent and longtime exposure of older dogs to the vector of the parasite (Egege et al., 2009). It is posited that dogs within the age range recorded in this study are very active and roam about indiscriminately thereby exposing themselves to tick infection which might account for the high prevalent rate of canis babesiosis recorded in our study. Again, the habit of assembling in the mating season and style of playing in the field may influence high tick infestation of dogs. However, studies have shown that canis babesiosis increases with age but declines when the dogs are about 4-5 years old (Hornok et al., 2006).

In this study, local breed has the highest infection (p<0.05) of 36% compared to exotic breed (6%) and crossed breed (12%). Similar result was recorded in Abuja by Jegede et al. (2014) and Daniel et al. (2006) in Jos.

This could be as a result of poor management system and lack of care for the local breed by their owners. This local breed is allowed to roam freely in the street to scavenge, hence, they are vulnerable to high tick infestation. Moreso, they are hardly immunized and are breed in very poor hygienic condition (Kamani et al., 2011; Eguche et al., 2020). In this study, there was no recorded significant prevalence in babesiosis infection in relation to breed of dogs. However, several studies have suggested that breed is a predisposing risk factor in babesiosis infection (Hornk et al., 2006; Mellanby et al., 2011). The reason for this is not clear but may be related to differences in genetic
composition (Obeta et al., 2020). The result obtained in our study is at variant with the report of Nalubamba et al. (2015) and Obeta et al. (2020). The researchers reported high prevalence of canis babesiosis in exotic breed in Zambia and Abuja, Nigeria respectively.

Unconfined dogs, presence of tick on dogs, irregular vaccination were the risk factors associated were some of the risk factors identified. Dogs used for hunting had high frequency of infection than others. This is in agreement with previous studies (Costa-junior et al., 2009; Veneziano et al., 2018). This might be as attributed to the adopted management techniques. The results also indicated that dogs in urban and rural areas are equally vulnerable to the infection. This is in consonance with the record of Silva et al. (2012).

CONCLUSION
Babesia spp. remains a health challenge among dogs in the study area irrespective of the risk factors. However, free-range and hunting dogs were at high risk of infection. Due to the physiological, behavioural and nutritional effect of the canis babesiosis on dogs, prevention and control remains a viable option, through modern management system, vaccination, use of acaricide and regular fumigation of the environment.

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Conflict of interest
The authors declared that there is no conflict of interest.

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96
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