PARASITE
EPIDEMIOLOGY
AND CONTROL

Prevalence of canine babesiosis and their risk factors among asymptomatic dogs in the federal capital territory, Abuja, Nigeria

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Babesia sp. are intracellular parasitic organisms that affects mainly the red blood cells of most mammals, causing the disease known as babesiosis, and transmitted by ticks. Babesisosis is potentially fatal and a major disease of dogs in Nigeria. Therefore, active and routine surveillance is recommended. In this study, the infection was investigated among apparently healthy domestic dogs in six Area Councils of the Federal Capital Territory (FCT), Abuja, Nigeria with the aim of determining the prevalence of the infection and the associated risk factors. Blood samples were collected from dogs ($n = 480$) at randomly selected households, from September 2015 to August 2016. Data regarding sampling location, sex, age, breed, use, presence or absence of ticks were recorded. Blood smears were prepared, stained with Geimsa stain, and examined under light microscope for Babesia sp. The results showed an overall prevalence of 10.8% Babesia canis infection. The prevalence among dogs examined in the six Area Councils were 6.3%, 12.5%, 10.0%, 12.5%, 11.3%, and 12.5 % for Abaji, AMAC, Bwari, Gwagwalada, Kuje and Kwali Area Council, respectively. The prevalence was highest (12.5%) among dogs from Kwali, AMAC and Gwagwalada, and lowest 5 (6.3%) among dogs from Abaji. Of the infected dogs, 13.7% were females and 8.3%, males. Dogs between 12 < 36 months old had the highest (17.0%) prevalence of infection while those of >60 months of age had the lowest (4.5%). Based on breed, the infection was more prevalent among exotic dogs (12.9%) than cross breeds (9.4%). While none of pet dogs were positive for Babesia canis, prevalence of 11.1% and 11.3% were recorded for guard and hunting dogs, respectively. Tick infestation was recorded for 254 dogs of which 17.3% had Babesia canis while only 3.5% of 226 non-infested dogs were Babesia positive. Babesia infection during the rainy season was 14.6% while 3.5% of dogs were positive during dry season. The data on monthly prevalence showed that August and September had the highest (13.5%) prevalence while January and February had the lowest (2.0%). We conclude that the canine babesiosis in the FCT was significantly dependent on age, use of dogs, tick infestation, and season. Therefore, priorities should be given to these factors while instituting control measures against the infection.

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1. Introduction

Babesiosis is a disease caused by *Babesia* species which are tick-borne protozoan parasites of erythrocytes that infect a wide range of vertebrate hosts (Irwin, 2009) with a world-wide distribution (Parnell et al., 2008; Otranto et al., 2009). The *Babesia* parasites replicate in the red blood cells and initiate a mechanism of antibody-mediated cytotoxic destruction of circulating erythrocytes (Zygner et al., 2007). The disease is characterised by fever, splenomegaly, inappetence, weakness, lethargy, generalised lymphadenopathy, anaemia, haemoglobinuria and collapse associated with intra-and extravascular haemolysis, hypoxic injury, systemic inflammation, thrombocytopenia, and pigmenturia (Irwin, 2009). At the advance stage, abnormalities in multiple internal organs such as the lungs, kidneys, pancreases, and heart, have been reported (Abalaka et al., 2018).

Canine babesiosis also known as 'malignant jaundice' is a common and clinically significant disease caused by an apicomplexan protozoa parasite (Penzhorn et al., 2017). They are transmitted primarily through tick bites during blood meals (Natala et al., 2013) and as such can infect a wide variety of domestic and wild animals as well as humans (Schnittger et al., 2012). It is an emerging infectious disease (Solano-Gallego and Baneth, 2011) caused by two distinct species (Kučer et al., 2019), belonging to the genus *Babesia*, (Solano-Gallego and Baneth, 2011). The *Babesia canis* is morphologically characterised as large (2.5–5.0-μm) and *B. gibsoni* as small (1.0-to-2.5-μm) (Zygner et al., 2014). The *B. canis* has three sub-species (Torti et al., 2014), considered to be morphologically identical (Solano-Gallego et al., 2016), but recent molecular studies have shown differences in the severity of their clinical manifestations, tick vectors, genetic characteristics, and geographic distributions (Abalaka et al., 2018; Ajoke et al., 2019). The *B. canis canis* are transmitted by *Dermacentor reticulatus* in Europe (Barker et al., 2012), *B. canis vogeli* are transmitted by *Rhipicephalus sanguineus* in tropical and sub-tropical regions (Lavan et al., 2018), and *B. canis rossi* are transmitted by *Haemaphysalis leachi* in South Africa (Bashir et al., 2009). The *B. canis rossi* causes a frequently fatal infection in domestic dogs, even after treatment; *B. canis vogeli* gives a moderate and often clinically in-apparent infection although reports about its potential fatality are recently accumulating (Abalaka et al., 2018; Ajoke et al., 2019). The *B. canis canis* infections result in a more variable pathogenicity intermediate between *B. canis rossi* and *B. canis vogeli* (Uilenberg, 2006). *Babesia gibsoni* is the small *Babesia* that commonly appears as individual ring forms or pyriform bodies ranging between 1.0 and 2.5 μm in size (Conrad et al., 1991). The *B. gibsoni* was reported to be associated with infection of dogs in Asia, North America, northern and eastern Africa, and Europe (Conrad et al., 1991). Canine babesiosis is characterised by a wide range of clinical manifestations; from subclinical disease to life-threatening conditions, with severity of clinical signs, depending on the species involved and host immune response against the infection (De Tommasi et al., 2013). The diagnosis of canine *Babesia* infections and identification of each species has been based on host specificity and the morphology of the intra-erythrocytic forms in stained blood smear. The parasite usually occurs as a single pear-shaped piroplasm or in pairs or in multiple merozoites divided by binary fission within the erythrocyte (Soulsby, 1982). Recent advances in molecular biology techniques like Polymerase Chain Reaction (PCR) have made it possible to detect and identify piroplasms with greater sensitivity and specificity than the traditional methods (Jefferies et al., 2003). Reports have shown that no single drug was found to be sufficient for the treatment of babesiosis, especially *B. gibsoni* (Solano-Gallego and Baneth, 2011). Most of the drugs used for the treatment of canine babesiosis have side effect and do not prevent relapse of the infection (Köster et al., 2015). Dogs are most common domestic animals seen in almost every human settlement performing valuable roles in the society. In Nigeria, dogs are kept as pets, guards, for hunting, herding, breeding, as well as a source of animal protein among some ethnic groups (Opara et al., 2005; Aiyedun and Olugasa, 2012; Hambolu et al., 2014). Canine *Babesia* infection was first encountered in Nigeria, in 1962, and documented in the Veterinanary Department annual report, as a disease associated frequently with higher severity among imported dogs than the indigenous breeds Leeflang and Ilemobade (1977). In the Federal Capital Territory, sketchy reports of the infection exit in Gwagwalada Area Council (Obeta et al., 2009; Jegede et al., 2014). Therefore, this study aimed to determine the prevalence of canine babesiosis in the six area councils of the FCT and unveil the associated risk factors.

2. Materials and methods

2.1. Study area

The study was conducted in the Federal Capital Territory, Abuja-Nigeria. The city lies between latitude 8°35′′ and 9° 25′′ North of the Equator and longitude 6° 45″ and 7° 45″ East of the Greenwich Meridian with a land area of 8000 km^2. It has a Guinea Savannah type of vegetation; with annual rain-fall ranges from 1100 to 1600 mm. There are two major seasons: dry season (November–April) and rainy season (May–October) in each year. The maximum temperature is 37 °C and the minimum 30 °C (Adekayi, 2000; Balogun, 2001). The environmental conditions provide favourable and conducive conditions for the survival and propagation of ticks (Opara et al., 2017). It is bordered to the north by Kaduna State, east by Nasarawa; south by Kogi;

and to the west by Niger State respectively. Abuja has six Area Councils namely; Abaji, Bwari, Gwagwalada, Kuje, Kwali and Abuja Municipal (AMAC) (Fig. 1).

2.2. Study animals and **s**ample collection

A total of 480 apparently healthy dogs were randomly selected from households in the six Area Councils of the FCT, between September 2015 to August 2016 and sampled for blood and ticks, using anti- rabies vaccination campaign exercise as a tool. Information regarding sample location, sex, age, breed, dog use, presence or absence of ticks, were recorded. Dogs were placed in the following age brackets: Group1 were dogs (> 3 <12 months), Group 2 (12 < 36 months), Group 3 (36 < 60 months), and Group 4 (> 60 months) (Bashir et al., 2009). Breeds were categorized as; local, exotic and cross breed (Okubanjo et al., 2013). Dog use were categorized as; guarding, hunting and pet (Obeta et al., 2009). The method of WHO (1991), was adopted for the collection of blood samples. Five milliliters (5 mL) of blood sample was collected through the cephalic vein using 5 mL 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. The samples were transported to the Department of Parasitology and Entomology Laboratory, Faculty of Veterinary Medicine, University of Abuja, for parasitological analyses.

2.3. Parasitological and molecular analysis of blood samples

Parasitological analyses were carried out immediately after each sampling exercise using standard method (Hendrix and Robinson, 2006). Thin smears were prepared from the blood samples, air dried and fixed in methanol for 3–5 minutes. The slides were stained in 10% Giemsa for 2530 minutes and examined under oil immersion lens (×100) for presence of intra- erythrocytic merozoites of Babesia.

Genomic DNA was extracted from whole blood samples that tested positive Babesia infection and the 18S rRNA gene was amplified using genus specific primers. The PCR products were electrophoresed on 1.5% Agarose gel and then sequenced bidirectionally.

2.4. Data analysis

Data obtained were analyzed using Statistical Package for Social Science (SPSS, Chicago, IL, USA, and Version 20). Results expressed as percentages and presented in forms of tables. Thereafter, subjected to Chi-square analysis. Odds ratio at 95% confidence interval was used to assess the risk factors. Values of $P < 0.05$ were considered significant.

3. Results and discussion

The overall prevalence of Babesia sp. infection among dogs sampled from the six Area Councils of the Federal Capital Territory, Abuja was 10.8% (Table 1). Of the 480 dogs sampled, 52 (10.8%) tested positive for Babesia canis in blood smears. The Babesia species was identified morphologically as typical pear-shaped pyriform bodies in the red blood cell of infected dogs (Fig. 2). The results of molecular assay showed Babesia DNA amplification at 612 bp on gel electrophoretogram and the BLAST search analysis of the products showed 100% similarity with Babesia canis vogeli in the GenBank. In this study, we have reported an overall prevalence of 10.8% of B. canis vogeli infection among dogs examined in six Area Councils of the Federal Capital Territory, Abuja, Nigeria. This finding, to the best of our knowledge, represents a comprehensive investigation of the disease in the study area. The prevalence data reported in this study was based on blood smears method of analysis. It is adjured as the oldest technique and the most common diagnostic method still in used today in most developing countries (Mosqueda et al., 2012). Though the method is inexpensive and easy to perform, it is unable to differentiate parasite species. The route of the blood collection is important as some species of Babesia parasites adhere to endothelial cells (Jacobson, 2006), thereby enhancing diagnosis if the blood sample is obtained from a blood capillary of the ear or tail, as they contain a higher percentage of infected erythrocytes. Thick blood smear can detect low levels of parasitemia, especially in cases where large Babesia species are involved (Bose et al., 1995). The thick smear has advantage over thin smear as large number of erythrocytes is analyzed in a reduced amount of space thereby making it about ten times more sensitivity over that of thin smears (Bose et al., 1995). The high prevalence of Babesia infection recorded in our study is an indication of continuous challenge of Babesia infection at subclinical level among the dogs in the study area.

As regards to sampled sites, the prevalence of Babesia infections recorded highest (12.5%) among dogs from Kwali, Municipal and Gwagwalada Area Councils respectively, and lowest (6.3%) among dogs from Abaji, showing variations in distribution of Babesia infection in the six Area Councils, though not statistically significant (Table 1). The differences observed may be due to relative variations in the abundance of infected tick vectors and other risk factors such as dog use, management, and medical history. The morphological identity of ticks collected from sampled dogs showed that 99.9% were Rhipicephalus sanguineus (prominent hexagonal shaped basis capitulum and a dull-yellow colour) and 0.1% Amblyomma varieggatum (large-mouth parts, ornamented scutum, and legs with pale rings) (Walker et al., 2014). Of the (n=480) dogs sampled in this study, 254 (53%) were tick infested. As regards to sample sites, Bwari, Area Council had the highest (57.5%) tick infested dogs while Abaji was the lowest (47.5%). However, there was no significant (P>0.05) different among the sites and these correlates with the prevalence of Babesia infections recorded which may probably be due to similarity in geo-climatic conditions of the sites. Of the 254 (53%) tick infested dogs
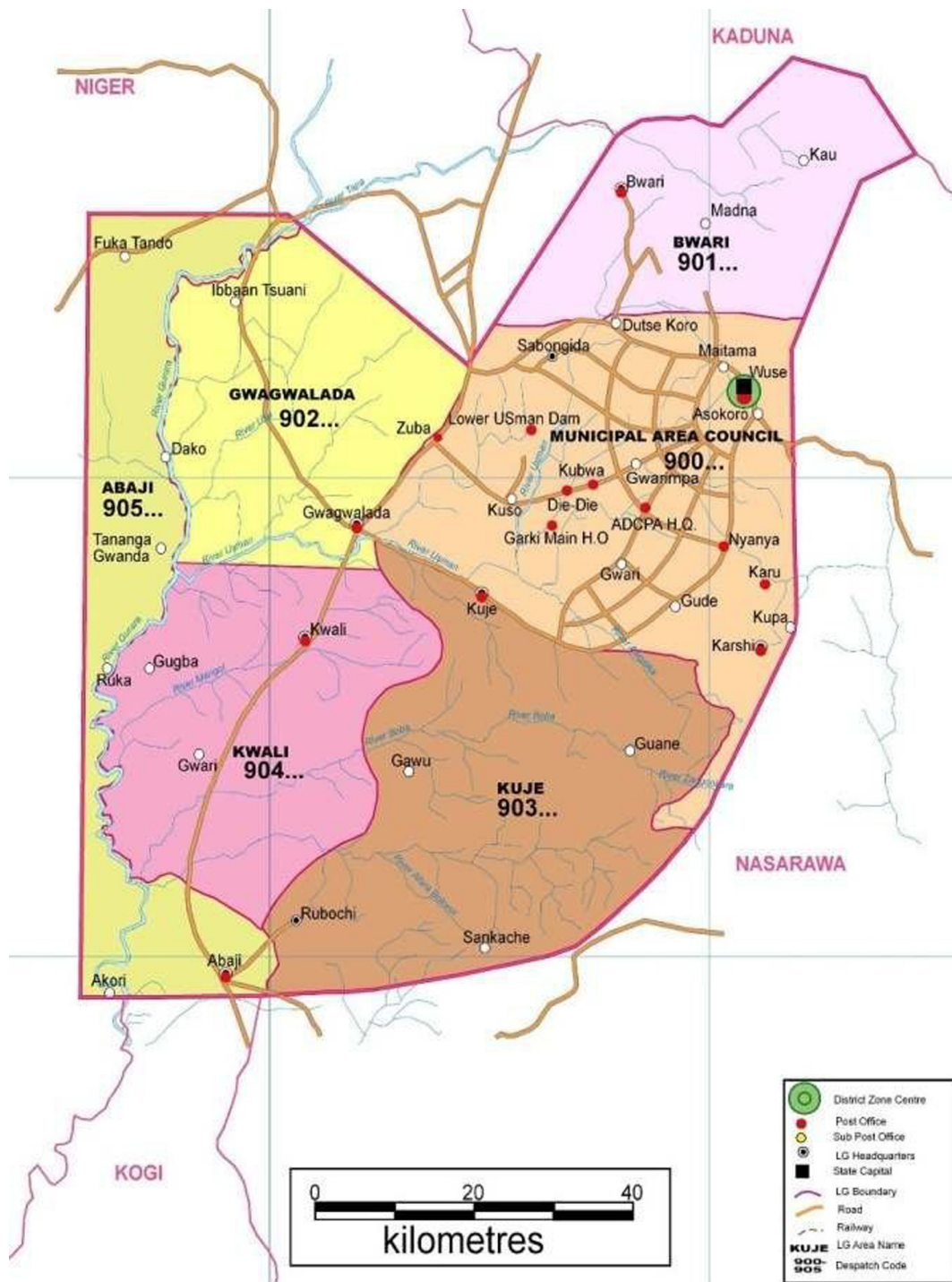
Fig. 1. A map of the Federal Capital Territory showing the six Area Councils (Source: https://www.google.com/search?q=map+of+abuja&sxsrf=ALeKk01-5r702YRS2iV).

examined for *Babesia* infection, 44 (17.3%) tested positive while only 8 (3.5%) were positive out of 226 (47%) non tick infested dogs. Our findings showed a significant difference $P > 0.05$ between occurrence of *B. canis* infection and tick infestation on dogs examined (Table 2) indicating correlation between tick infestation and *B. canis vogeli* infection in the territory. In the present study, tick infestation was higher among male dogs, local breed, hunting dogs, age categories of (36 < 60 months) and wet season of the year than their counterparts. However, there was no significant ($P > 0.05$) difference observed. Reports from previous studies have shown that risk factors associated with tick attachment in dogs are highly inconsistent (Jennett et al., 2013). The tick

abundance is strongly determined by differences in climate, host availability and vegetation cover, which affects their microclimate (Dantas-Torres, 2010). The prevalence of *Babesia canis* infection recorded in this study was relatively lower than the reports of Okubanjo et al. (2013) and Opara et al. (2017), who recorded 17.3% and 57.1% *B. canis* infection in Zaria and Gwagwalada Area Council respectively. The difference may be attributed to a transient parasitaemia particularly in early infection, as well as low and or in chronic cases (Bourdoiseau, 2006). Our prevalence was higher than that of Amuta et al. (2010), Jegede et al. (2014), and Takeet et al. (2017), who reported 10.2% 8.9% and 7.3%, of *B. canis*. infections in Markurdi, Gwagwalada, and Abeokuta, respectively. The reasons for the disparities could be due to differences in the experimental designs, study locations, duration of the study, season of the year, inclusions and exclusions criteria employed in the studies. Some of the studies examined more exotic breed of dogs which have been adjudged to be more susceptible to *Babesia* infection than the local breeds (Daniel et al., 2016). Opara et al. (2017), examined only local breed of dogs and suggested that the higher infections rate encountered may be due to lack of medical care and poor management. Daniel et al. (2016), reported 18.6% prevalence of *B. canis* infection in Jos, Plateau State, in which large sample size were employed in naturally infected cases. In our study, AMAC is the location of the seat of power of the Federal Government of Nigeria, and therefore the most developed in terms of social infrastructures compared to other Area Councils were dogs sampling was conducted. Surprisingly, dogs that were restricted to urban habitats were no less likely to have ticks than dogs in the rural habitats. This corresponds with the growing number of reports of high tick infestation in urban environments (Smith et al., 2013). This variation in results concurs with the works of Radostits et al. (1997), which reported that occurrence of *Babesia canis* infection could be governed by the geographical distribution of their tick vectors. The variation in the prevalence representation may be due to an increased susceptibility to infection or may be due to increased exposure to potential risk factors.

In this present study, male dogs were 1.24 times more prone to *Babesia* infection than the female dogs (Table 2). The sex of the animal may have influence in the occurrence of vector borne parasitic diseases. The temperament and hormonal status of male dogs may be a contributory factor as it could limit the attention and care given them even by their owners. Previous reports have shown an increase risk of canine babesiosis for male dogs as compared to female suggesting that the increased susceptibility may be due to differences in environmental exposure, such as increased roaming behavior, or by sex-linked genetic or hormonal influences on the disease (Mellanby et al., 2011). Further epidemiological and genetic studies are required to evaluate these factors. The present findings are in agreement with that of Daniel et al. (2016), who reported higher rate of *Babesia* infections among male than the female dogs. The reports showed that male dogs were more exposed to tick infestations due to higher tendency to roam about in search of mates and establish territories, than the female counterparts which were considered to receive better management from their owners for monetary gain from their puppies. The present study disagrees with some other studies of (Omudu et al., 2010; Okubanjo et al., 2013; Jegede et al., 2014; Opara et al., 2017) who reported that the prevalence of haemoprotozoa was higher in the female than male dogs, and reasoned that female dogs are usually more sedentary especially during nursing of their offspring, which predisposes them to increase infestation with tick vector. Also, the peculiar reproductive activities in the female animals may lead to stress and subsequent reduction in their immunity and resistance to tick-borne diseases. In this study, we reported that *B. canis* infection among dogs examined in age category of 12 < 36 months were two times more prone to infection than those in other age categories (Table 2). There was a significant ($P<0.05$) association between age and prevalence of *Babesia* infections in dogs in the FCT. The higher rate of *Babesia* infection in the age ranges of 1–3 years, may probably be a reflection of lowered maternal immunity/resistance associated with older dogs as well as frequent exposures to tick bites (Egege et al., 2008). Our findings agree with the previous studies of Hornok et al. (2006) who reported that the canine babesiosis increase with age, reaching its peak between the age of 3 and 5 years and then decline. In some protozoan infections, most of the neonates of chronically infected mothers show a higher degree of immunity to the homologous parasites than those born of normal mothers. The report of this study is in agreement with previous works of (Obeta et al. (2009) and Opara et al. (2017), who suggested that the presence of maternal immunity in younger dogs helps them to resist infections with blood parasites (Taylor et al., 2007). It is our opinion that dogs in this group are more agile and might likely roam about indiscriminately if given the opportunity, which could predispose them to tick infestations. In addition, their habit of playing on the grasses may contribute to their predisposition to questing ticks. The congregation of dogs usually during mating season could also contribute in exposing them to cross infestation with ticks. However, there are contrary reports from other researchers (Taylor et al., 2007; Okubanjo et al., 2013), that younger dogs were more susceptible to *Babesia canis* infection than the adult dogs, due to their underdeveloped immune system. Studies have shown that canine babesiosis is a disease of young dogs even

Table 1
Prevalence of *Babesia* infection among dogs in the six Area Council of the FCT.

Location	Dogs examined	No. positive	(%) positive
Abaji	80	5	6.3
AMAC	80	10	12.5
Bwari	80	8	10.0
Gwagwalada	80	10	12.5
Kuje	80	9	11.3
Kwali	80	10	12.5
Total	480	52	10.8

DF = 5, *P* = 0.208.
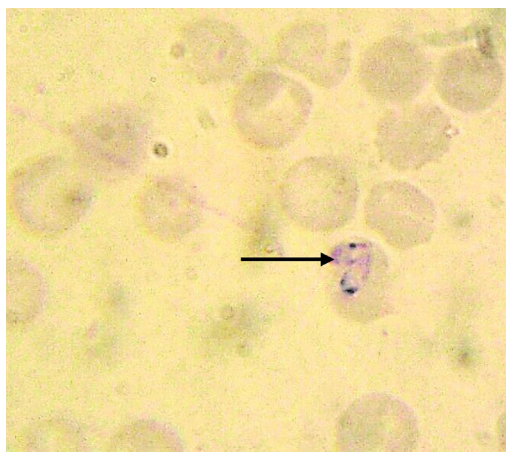
Fig. 2. Intra-erythrocytic *Babesia* merozoite in Giemsa-stained smears (×1000) showing pyriform bodies with basophilic cytoplasm and reddish chromatin, from dogs in the FCT.

as young as 3 weeks and that older dogs coming from a *Babesia*-free zone can develop the disease when challenged with an infected tick during a brief stay in an endemic zone (Ogo et al., 2011).

In the present study, we reported higher (12.9%) prevalence of *Babesia* infection among exotic breeds as compared to local (11.3%) and crossbreed (9.4-%) respectively, (Table 2). The reason may be due to fewer (12.9%) number of exotic breeds examined as compared to cross-breed (35.4%) and higher (51.6%) local breed encountered in this study. It may also be due to an increased susceptibility to the bite of infected tick vectors or increased exposure to other potential risk factors. It is our opinion that both factors may have contributed to our findings, as dogs coming from a *Babesia*-free zone into an endemic zone like ours may have high susceptibility to infection (Ogo et al., 2011). Some studies have shown that babesiosis is most frequent with higher severity among imported dogs than indigenous breeds (Leeflang and Ilemobade 219. 1977). However, no significant ($P > 0.05$) association was observed between the *B. canis* infection and dog breeds. Mellanby et al. (2011), reported that all breeds of dogs are

Table 2
Prevalence of *Babesia* infection among dogs examined in the FCT based on sex, age, breed, dog use, tick infestation and season.

Parameters	No. of dogs examined (n = 480)	No. positive	(%) positive	Odds ratio	Confidence interval
Sex					
Male	227	31	13.7	1.24	0.73–2.11
Female	253	21	8.3	1.00	–
DF = 5, P = 0.208					
Age (month)					
> 3 < 12	170	11	6.5	0.58	0.28–1.78
12 < 36	194	33	17.0	1.00	–
36 < 60	94	7	7.4	0.26	0.82–6.42
>60	22	1	4.5	0.72	0.62–3.4
DF = 3, P = 0.00					
Breed					
Exotic	62	8	12.9	1.16	0.50–2.69
Cross	170	16	9.4	0.82	0.43–1.56
Local	248	28	11.3	1.00	0.22–1.32
DF = 3, P = 0.71					
Dog use					
Guard	395	44	11.1	2.78	0.46–16.71
Hunting	71	8	11.3	2.83	0.47–17.00
Pet	14	0	0	1.00	0.12–2.61
DF = 2; P = 0.37					
Tick infestation					
Present	254	44	17.3	4.9	2.5–11.8
Absent	226	8	3.5	1.0	1.22–7.6
DF = 1, P = 0.09					
Seasons					
Wet season	240	35	14.6	2.08	0.56–1.62
Dry season	240	17	7.1	0.98	0.63–1.70
DF = 1, P = 0.022					

Table 3
Prevalence of *Babesia* infection among dogs examined in the FCT according to calendar months.

Month	No of dogs sampled	*Babesia* infection	Odds R	Lower CL	Upper CL
May	40	5	0.14	0.74	4.34
October	40	6	0.21	1.17	5.78
September	40	7	0.21	1.17	5.78
August	40	7	0.21	1.17	5.78
November	40	5	0.14	0.74	4.34
February	40	1	1.00	0.00	0.00
June	40	6	0.18	0.84	4.98
March	40	3	0.08	0.55	4.26
April	40	3	0.08	0.55	4.26
July	40	4	0.11	0.66	5.05
December	40	4	0.11	0.66	5.05
January	40	1	1.00	1.00	1.00

not uniformly at risk for developing babesiosis, as Toy breeds have lower risk than other breed of dogs. The reason for this hypothesis is unclear but may be related to decreased exposure to tick vectors due to better management given as pet or may be related to genetic differences in susceptibility to the disease. Several reports have shown that breed predisposition to *Babesia* infections do occur, citing the vulnerability of the German shepherd breeds to developing babesiosis due to *B. canis* (Hornok et al. 227. 2006). Predisposition of breeds of dogs to *B. canis* (Martinod et al., 1986), *B. vogeli* (Taboada et al., 1992), *B. gibsoni* (Birkenheuer et al., 2005) and *B. rossi* (Mellanby et al., 2011) infections have been described in different parts of the world. However, our findings are not in agreement with that of Jegede et al. (2014) who reported a higher prevalence of canine babesiosis in local dogs than exotic, though statistically not significant, and suggested that nonchalant attitude of local dog owners towards the medical needs of their animals could be the reason. The present study showed that local dogs had a higher risk of acquiring the infection than the cross breeds and this report is in line with the work of Daniel et al. (2016), who reported higher infection rate in local breeds as they are not expensive to acquire, owners tends to neglect them to stray and scavenge, which increases their exposure to ticks.

The occurrence of canine *Babesia* infections was significantly higher in rainy season than in the dry season (Table 2). The probable reason may be a correlation with the seasonal activity of *Rhipicephalus sanguineus* (brown dog ticks) which is most abundant in wet and humid period of the year, thus resulting to higher transmission rate and thus higher prevalence of *B. canis* infections in the season (Soulsby 1982). In this study we recorded highest (17.5%) prevalence of infection in August and September and lowest (2.5%) prevalence in January and February (Table 3). This result is in agreement with findings of Konto et al. (2014), who reported high tick infestations in dogs during the months of wet season than the dry season months. The reason could be due to availability of vegetation cover which provides favourable environment for ticks during rainy season, as ticks are noted to drop off the host to moult and quest on blades and attach on hosts that come in contact with them during grazing or movement (Shitta et al., 2011). It has also been reported that optimum temperature and high humidity may encourage high fecundity in ticks (Konto et al., 2014). There is growing interest in the use of canine babesiosis as a naturally occurring model of falciparum malaria in humans (Reyers et al., 1998). Both diseases share numerous clinical and pathophysiologic characteristics such as hemolysis, hypoglycemia, severe systemic inflammation and associated proinflammatory cytokine production (Keller et al., 2004). There is an increased understanding of the genetic factors involved in host susceptibility to malaria (Verra et al., 2009). Further evaluation of the role of host genetics and environment in influencing the risk of developing babesiosis may offer insights into the pathogenesis of falciparum malaria in humans, because the effect of parasite genotype might be as important as host predisposition.

4. Conclusions

This study has reported 10.8% prevalence of canine babesiosis caused by *B. canis vogeli* species among asymptomatic dogs investigated in six Area Councils of the FCT, indicating constant challenge of the parasite and their vectors. The prevalence of the disease was associated with age, reaching its peak among (12 < 36) months age category and then declined. The prevalence of *Babesia* infections in this study was not breed dependent, however the infection rate was higher among exotic breed than the local or cross bred, demonstrating that all breeds of dogs are not uniformly at risk for developing babesiosis. The prevalence of the infections was not sex dependent; however, we have reported an increased risk of canine babesiosis among male dogs than female. This study demonstrated significantly, that *Babesia* infections was dependent on infestation rate of tick vector on the canine host and on the use of dogs, as hunting dogs were significantly more infected compared to guard or pet dogs. *Babesia* infection was higher in rainy seasons than dry season due to higher prevalence of tick vectors. The environmental conditions of our study area provide favourable and conducive climate for the survival and propagation of ticks throughout the year. Therefore, priorities should be given to these factors while instituting control measures against tick-borne diseases.

Ethical consideration

Ethical approval for the study was obtained from the Ethics Committee on Animal Use and Care, University of Abuja, Abuja. All animals were sampled with the owner's consent and handled humanely.

Declaration of Competing Interest

None

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