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Prevalence of Haemoparasitic Infections and Associated Risk Factors Among Hunting Dogs in Ilorin Metropolis, Kwara State, Nigeria

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ABSTRACT
Haemoparasitic infections are common in dogs and are particularly relevant in hunting dogs because of their frequent exposure to tick-infested environments. However, limited information exists on the occurrence of these infections among hunting dogs in Ilorin metropolis. This study therefore determined the prevalence of haemoparasites and associated risk factors among hunting dogs in Ilorin metropolis, Nigeria. A total of 75 hunting dogs were sampled from four locations in Ilorin metropolis between May and July 2025, comprising 41 (54.7%) males and 34 (45.3%) females. Of these, 23 (30.7%) were less than two years old, 14 (18.7%) were above two years old, while the ages of 38 (50.7%) were unknown. Blood samples were examined microscopically following preparation of thin blood smears. The overall prevalence of haemoparasites was 53.3% (40/75). *Babesia spp. and Ehrlichia spp*. were the predominant haemoparasites, with prevalence of 26.7% (20/75) and 25.3% (19/75), respectively, while mixed infection was recorded in 1.3% (1/75) of the dogs. Haemoparasite infection was detected in 58.5% of males and 47.1% of females. Odds ratio analysis showed that male dogs were 1.59 times more likely to be infected than females. However, haemoparasite infection was not significantly associated with age (p = 0.098), sex (p = 0.32), or body condition score (p = 0.62). The findings indicate a high occurrence of haemoparasitic infections among hunting dogs in Ilorin metropolis, with *Babesia spp. and Ehrlichia spp*. being the predominant parasites identified. This highlights the need for appropriate preventive measures.

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INTRODUCTION

Hunting dogs are used to locate, pursue, and retrieve wild animals, often in rural and wooded environments. Their frequent exposure to these environments, where ticks are abundant, and close contact with other dogs may increase their risk of tick infestation and exposure to tick-borne pathogens (Cortese *et al.,* 2020). Tick-borne diseases (TBDs) are increasingly recognised as important diseases of dogs worldwide, with several pathogens reported in different regions (Sgroi *et al.,* 2022). In Nigeria, important vector-borne pathogens (VBPs) reported in dogs include *Babesia rossi, Ehrlichia canis, and Hepatozoon canis* (Gruenberger *et al.,* 2023). The brown dog tick, *Rhipicephalus sanguineus*, is an important vector of several of these pathogens (Ybanez *et al.,* 2018). Molecular diagnostic methods have also detected other pathogens in Nigerian dogs, including *Babesia vogeli*, *Anaplasma platys*, *Mycoplasma haemocanis*, *Candidatus Mycoplasma haematoparvum*, *Theileria* spp., and *Trypanosoma* spp., although at lower prevalence (Aquino *et al.,* 2016; Kamani *et al.,* 2019).

In Nigeria, diagnosing canine blood-borne infections has traditionally relied on clinical examination and microscopic detection of pathogens in peripheral blood, while molecular diagnostic methods are less commonly used (Happi *et al.,* 2018).. Although microscopy is relatively simple, affordable, and accessible, its sensitivity may be reduced when parasitaemia is low, and accurate identification requires adequate technical expertise (Araújo *et al.,* 2025; Prasitsuwan *et al.,* 2025). Molecular techniques, including polymerase chain reaction (PCR)-based assays, offer greater sensitivity and specificity and are widely used to detect and differentiate *Babesia* and other blood-borne pathogens (Akande *et al.,* 2017; Happi *et al.,* 2018; Prasitsuwan *et al.,* 2025).

However, information on the prevalence of haemoparasitic infections and associated risk factors among hunting dogs in Ilorin metropolis, Kwara State, Nigeria, remains limited highlighting the need for studies in this population.

Despite the advantages of molecular methods, light microscopy remains a practical diagnostic approach in many resource-limited settings. Therefore, this study used light microscopy to investigate blood-borne infections in hunting dogs. This study aims to determine the prevalence of haemoparasitic infections and evaluate associated demographic and clinical risk factors among hunting dogs in Ilorin Metropolis, Kwara State, Nigeria.

MATERIALS AND METHODS

Study Area

The study was carried out in Ilorin metropolis, Kwara State, Nigeria. Kwara State is located between latitude 8º 05N and 10º 15N, longitude 2º 73E and 6º 133E. It lies in the middle belt within Nigeria's forest savannah region (Ola-Fadunsin *et al.,* 2023). The state is bordered in the west by the Benin Republic, in the east by Kogi State, and in the South by Oyo, Osun and Ekiti States. According to the 2006 National Census, Kwara State's population was 2,371,089 people, and

its total area was 32,500 square kilometres, or 8% of Nigeria's land area (Tunde & Ajadi, 2019). The climate of Ilorin is characterised by both wet and dry seasons. The rainy season starts in late April and lasts until October, while the dry season starts in November and ends in April (Olubanjo, 2019).

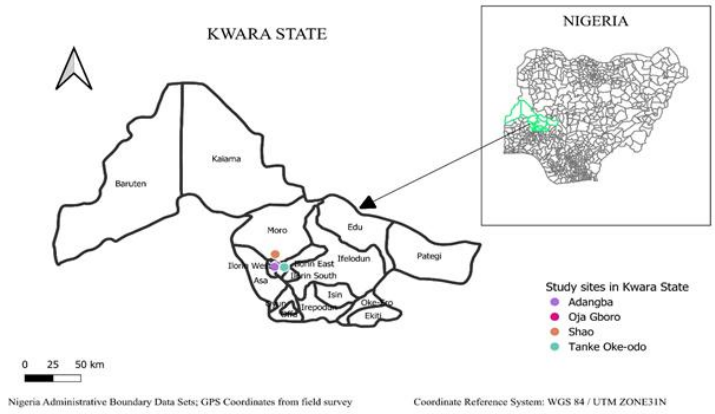


Figure 1: Map of Ilorin Metropolis Showing the Hunting-Dog Sampling Locations in Kwara State, Nigeria (Design Using QGIS Version 3.4.4)

Study Design and Sample Size Determination

This cross-sectional study calculated the prevalence of haemoparasite infections among hunting dogs in the Ilorin metropolis of Kwara State, Nigeria. Data on demographic and managerial factors were collected from the dogs and their owners, while blood samples were collected and examined for haemoparasite parasites during the study period. The minimum sample size was calculated using the the method of Thrusfield (2007) ; $N=Z^2P(1-P)/d^2$, where Z is the standard normal deviate at a 95% confidence level (1.96), P is the expected prevalence of hemoparasite infection (13.3%) (Peter *et al.,* 2019) and d is the desired precision (10%). The calculated minimum sample size was 45 dogs. Allowing for potential non-response, the sample size was adjusted accordingly. However, we sampled 75 hunting dogs from owners who volunteered to participate in this study.

Sample Strategy, Animal Handling and Sample Collection

We used a non-probability convenience sampling to select dogs based on hunters and owners permission. Hunting dogs were gently restrained by a trained handler to minimize stress and prevent injury during blood collection.75 Blood samples were collected through the cephalic vein of each dog using a syringe and needle into ethylenediaminetetraacetic acid (EDTA) tubes to prevent coagulation. The age, sex and body condition score of each dog were carefully labelled and recorded. It was then placed in a thermocool box. This was then transported to the research Laboratory of the Department of Veterinary Parasitology and Entomology, University of Ilorin, Kwara State, for analysis.

Inclusion Criteria

Hunting dogs kept or used for hunting activities within Ilorin metropolis were eligible for inclusion. Dogs were enrolled following informed consent from their owners and were included in the analysis when blood samples were successfully collected and examined.

Ethical Approval

This study followed the ethical standards and guidelines of the Faculty of Veterinary Medicine, University of Ilorin, Institutional Animal Care and Use Committee (IACUC). Approval No. URE/FVM/2025/029.

Microscopic Examination

A thin blood smear was prepared for each sample. A small drop of blood (approximately 1–2 µL) was placed on a clean glass microscope slide about 1 cm from one end. A second clean slide was held at a 45° angle to the slide containing the blood drop to spread the blood into a thin film by capillary action (Ehimiyein *et al.,* 2018; Prasitsuwan *et al.,* 2025). The smear was then air-dried completely at room temperature without heat. Once dried, the smear was fixed by immersing it in absolute methanol for 1-2 minutes to preserve cellular morphology. The slide was then air-dried before staining with 5% Giemsa stain, a commonly used stain for identifying hemoparasites. The smear was then flooded with the stain and left for 15–20 minutes. After staining, the slide was gently rinsed with buffered water and air-dried (Prasitsuwan *et al.,* 2025). A drop of immersion oil was then applied, and the smear was examined under a 100x oil immersion objective for detailed visualisation of potential hemoparasites.

Morphological Identification of *Ehrlichia canis* and *Babesia* spp

Using morphological criteria outlined in classic veterinary parasitology texts, such as Soulsby (1982) and Taylor *et al.* (2007), Giemsa-stained thin blood smears were microscopically inspected for the presence of hemoparasites. While *Babesia* spp. were detected by the presence of morphologically distinctive intraerythrocytic piroplasms, suspected *Ehrlichia canis* infection was evaluated by looking for morula-like inclusions inside monocytes.

The evaluation took into account the probable organisms' intracellular location, size, shape, organization, and staining properties. Suspected parasites were carefully separated from other cellular components and staining artifacts. Results were documented based on the observed morphological criteria.

Determination of Age, Sex and Body Condition Score

Information on the age and other relevant management practices of each hunting dog was obtained from the respective owners through direct interview using a structured questionnaire. The body condition of each hunting dog was assessed by visual observation and classified into three categories: 1= poor/thin, 2=moderate/ normal, and 3=good/ over-conditioned

Statistical Analysis

Data were entered into IBM SPSS® Statistics, version 23 (IBM Corp., Armonk, NY, USA), for statistical analysis. Descriptive statistics summarised dogs' demographic characteristics (age, sex, and body condition score). We described categorical variables using frequencies and percentages and compared them using chi-squared tests or Fisher exact tests, as appropriate. We considered $p < 0.05$ significant. We calculated odds ratios and 95% confidence intervals in Microsoft Excel, using the reference category (OR = 1) as the comparator for each variable.

RESULTS AND DISCUSSION

Results

Of the 75 hunting dogs sampled, 40 (53.3%) tested positive for at least one haemoparasite; slightly more than half the population was infected. *Babesia* spp. and *Ehrlichia* spp. were similarly prevalent, at 20/75 (26.67%) and 19/25 (25.33%), respectively, with mixed infection rare at 1/75 (1.33%). This indicates single infections were far more common than co-infections. Under half the dogs (35/75; 46.67%) were negative for both parasites, as shown in Table 1.

Table 1: Prevalence of Haemoparasite Infection in Hunting Dogs in Ilorin, Nigeria

Parasite	No. of infected dogs	Prevalence (%)
Babesia spp	20	26.67
Ehrlichia spp	19	25.33
Babesia + *Ehrlichia*	1	1.33
No parasite	35	46.67

We assessed haemoparasite prevalence by sex, age group, location, and body condition score (BCS), and found no statistically significant associations with any of these variables.

Prevalence was higher in males (58.5%; 24/41) than in females (47.1%; 16/34), but the difference was not significant ($p = 0.32$). Dogs older than 2 years had a higher prevalence of 64.3% (9/14) than those aged ≤2 years (34.8%; 8/23), while dogs of unknown age had a prevalence of 60.5% (23/38). This difference was not significant ($p = 0.098$). Dogs older than 2 years had higher odds of infection compared to those aged ≤2 years (OR = 3.38, 95% CI: 0.84–13.55).

Body condition score was not associated with infection ($p = 0.62$), with prevalence of 43.8% (7/16), 57.4% (27/47) and 50.0% (6/12) for scores 1, 2 and 3, respectively. Dogs with a score of 2 (OR = 1.74, 95% CI: 0.55–5.45) and a score of 3 (OR = 1.29, 95% CI: 0.29–5.77) had higher odds of infection than those with a score of 1, but the confidence intervals were wide and included 1

By location, prevalence was highest in Shao 64.0% (16/25), followed by Adangba 55.6% (10/18), Ojagboro 54.2% (13/24) and Oke-odo 12.5% (1/8), but this difference was not significant ($p = 0.09$) dogs from Ojagboro (OR = 8.27, 95% CI: 0.88–78.0), Shao (OR = 12.44, 95% CI: 1.31–117.9) and Adangba (OR = 8.75, 95% CI: 0.88–86.6) all had markedly higher odds of infection compared to Oke-odo. Notably, the confidence interval for Shao was the only one that excluded 1, because of the very small sample size in Oke-odo (n = 8).

Table 2: Prevalence and Risk Factors Associated with Haemoparasite Infection in Hunting Dogs in Ilorin

Variables	Category	No. Infected (%)	No. Uninfected (%)	OR	95% CI	P-value
Sex	Female	16 (47.1)	18 (52.9)	1	—	0.32
	Male	24 (58.5)	17 (41.5)	1.59	0.64–3.97	
Age	≤2 years	8 (34.8)	15 (65.2)	1	—	0.098
	>2 years	9 (64.3)	5 (35.7)	3.38	0.84–13.55	
	Unknown	23 (60.5)	15 (39.5)	2.88	0.98–8.44	
Body Condition Score	1	7 (43.8)	9 (56.2)	1	—	0.62
	2	27 (57.4)	20 (42.6)	1.74	0.55–5.45	
	3	6 (50.0)	6 (50.0)	1.29	0.29–5.77	
Location	Oke-odo	1 (12.5)	7 (87.5)	1	—	0.09
	Ojagboro	13 (54.2)	11 (45.8)	8.27	0.88–78.0	
	Shao	16 (64.0)	9 (36.0)	12.44	1.31–117.9	
	Adangba	10 (55.6)	8 (44.4)	8.75	0.88–86.6	

OR = Odds Ratio; CI = Confidence Interval; Reference Category for Each Variable (OR = 1) is Female (Sex), ≤2 Years (Age), Body Condition Score 1, and Oke-odo (Location). Body Condition Score: 1 – Very Thin, 2 – Under Weight/ Slim, 3- Ideal Weight

Discussion

The overall haemoparasite prevalence in the present study was 53.3%, which was higher than those reported in previous Nigerian studies: 19.67% in Zaria (Ehimiyein *et al.,* 2018), 14.16% in Maiduguri (Ezema *et al.,* 2021), 6.9% in Yobe (Audu *et al.,* 2022), and 29.2% in Ilorin (Peter *et al.,* 2019). It was also higher than the 12% reported in Nepal (Phuyal *et al.,* 2017) and 18.8% reported in India (Sumbria *et al.,* 2024). Of these studies, only the Zaria study specifically investigated hunting dogs, making it the most directly comparable. The higher prevalence observed in the present study may be related to the environmental exposure associated with hunting activities. Hunting dogs spend considerable time in bush and rural environments, where contact with vegetation, wildlife, and other potential hosts may increase opportunities for tick exposure(Akande *et al.,* 2017). Most of the dogs sampled in the present study were from rural parts of Ilorin.

Babesia (26.67%) and *Ehrlichia* (25.33%) accounted for most of the overall prevalence. The prevalence of *Babesia* was higher in this study than in previous Nigerian reports of *Babesia* in Zaria (16.39%), Ogun State (22%), Maiduguri (12.50%), Yobe (5.2%), and Ilorin (22.9%) (Akande *et al.,*

2017; Audu *et al.,* 2022; Ehimiyein *et al.,* 2018; Ezema *et al.,* 2021; Peter *et al.,* 2019). Similarly, *Ehrlichia* prevalence was higher than the 1.64% reported in Zaria, 1.66% in Maiduguri, and 4.1% in Ilorin, as well as the 8% reported in Nepal (Ehimiyein *et al.,* 2018; Ezema *et al.,* 2021; Peter *et al.,* 2019; Phuyal *et al.,* 2017). *Babesia* was slightly more prevalent than *Ehrlichia* in the present study, a pattern also reported in Zaria, Maiduguri, and Ilorin, whereas *Ehrlichia* was more prevalent in Nepal, which may reflect geographical location and differing climatic conditions across regions.

The findings from the two other Nigerian studies involving hunting dogs provide a useful comparison. In Zaria, Ehimiyein *et al.* (2018) reported an overall haemoparasite prevalence of 19.67%, with *Babesia* and *Ehrlichia* detected at 16.39% and 1.64%, respectively. In Ogun State, Akande *et al.* (2017) reported a *Babesia* prevalence of 22% using microscopic examination. The lower prevalence reported in these hunting-dog populations suggests that hunting activity alone may not account for the higher prevalence observed in the present study. Differences in geographical location, vegetation, climate, local tick populations, and dog management may have contributed. In the Zaria study, samples were collected near the Veterinary Teaching Hospital (Ehimiyein *et al.*, 2018), whereas many dogs in the present study were sampled from rural areas, some relatively distant from veterinary facilities. Differences in access to veterinary care and tick-control measures may therefore have influenced exposure.

The prevalence of mixed *Babesia* and *Ehrlichia* infection was 1.33%, which was lower than the 1.64% reported in Zaria and 2.1% previously reported in Ilorin (Ehimiyein *et al.,* 2018; Peter *et al.,* 2019). Co-infection may occur when dogs are exposed to ticks carrying more than one pathogen(Sharma *et al.,* 2025). However, the low prevalence observed in the present study may reflect differences in pathogen circulation, vector exposure, and dog management.

Regarding sex, 58.5% of male dogs and 47.1% of female dogs were positive for at least one haemoparasitic infection, although the difference was not statistically significant. A similar pattern was reported among hunting dogs in Zaria, where prevalence was 23.08% in males and 13.64% in females (Ehimiyein *et al.,* 2018). The higher observed prevalence among males may reflect differences in exposure if male hunting dogs are used more frequently or travel over wider areas. A greater predisposition among males has also been suggested by Amissah-Reynolds *et al.* (2016). However, this pattern is not consistent across studies. Akande *et al.* (2017) reported a higher prevalence among female hunting dogs in Ogun State, while Sumbria *et al.* (2024) reported a higher prevalence among females in India. These contrasting findings, together with the lack of a statistically significant association in the present study, suggest that sex alone may not be an important determinant of haemoparasite infection in this population.

Older dogs had a higher prevalence of haemoparasitic infection than younger dogs in the present study, although the difference was not statistically significant. This observation agrees with findings from Akande *et al.* (2017) and Ehimiyein *et al.* (2018), who reported higher prevalence among dogs aged 1–3 years than those younger than one year. Similarly, Phuyal *et al.* (2017) reported higher prevalence among dogs aged 2–4 years. The higher prevalence observed among older dogs may reflect longer cumulative exposure to tick-infested environments, particularly among dogs regularly involved in hunting activities (Akande *et al*., 2017). However, the absence of a statistically significant association in the present study indicates that age was not associated with haemoparasite infection in this population.

Dogs with a body condition score (BCS) of 2 had the highest observed prevalence of haemoparasitic infection, but the association between BCS and infection was not statistically significant. Limited information is available for direct comparison of BCS and haemoparasitic infection among hunting dogs. This finding indicates that infection occurred across different body condition categories and that BCS alone may not reliably indicate infection status. Therefore, the higher prevalence observed among dogs with a BCS of 2 does not establish an association between poor body condition and haemoparasite infection.

We did not assess tick burden, tick species, or detailed management practices, limiting our ability to determine their contribution to infection. Future studies combining molecular diagnostic methods with tick surveys and detailed assessment of dog management practices would provide a clearer understanding of haemoparasite transmission among hunting dogs in Ilorin metropolis.

A major limitation of this study was the large proportion of dogs (50.7%) with unknown age, which limited the precision of the age-based analysis and may have obscured a possible association between age and haemoparasite infection. In addition, small sample sizes in some subgroups, particularly Oke-odo (n = 8) and dogs older than 2 years (n = 14), produced wide confidence intervals for the estimated odds ratios, limiting the precision of these estimates.

CONCLUSION

This study found a relatively high prevalence of haemoparasite infection among hunting dogs in Ilorin metropolis, with *Babesia* and *Ehrlichia* being the predominant infections detected. Although higher infection rates were observed among males, older dogs, and dogs with lower body condition scores, none of these factors was significantly associated with infection. The findings highlight haemoparasitic infections among hunting dogs and the need for improved surveillance and preventive measures, particularly in dogs with frequent exposure to rural and bush environments. Further studies using molecular diagnostics, alongside assessment of tick burden and management practices, are recommended to better characterize the burden and transmission of these infections.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest among them.

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