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ORIGINAL RESEARCH ARTICLE

Incidence of Furuncular Myiasis due to *Cordylobia anthropophaga* (Blanchard, 1872) Larvae Infestation and Associated Risk Factors on Dogs in Ilorin Metropolis, North Central, Nigeria

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ABSTRACT

It is impossible to overstate the dangers that an infestation of *Cordylobia anthropophaga* (Blanchard, 1872) larvae poses, particularly to household pets. This study aims to ascertain the prevalence of furuncular myiasis in dogs presented to private and public veterinary clinics in the Nigerian state of Kwara, specifically in the capital of Ilorin, caused by the larvae of *C. anthropophaga*. With three distinguishing slits and two posterior spiracles, the 84 larvae that were removed from 61/268 (22.76%) dogs infected with myiasis were recognized as third-stage *C. anthropophaga* larvae. According to the data gathered, Cordylobiosis is also more common in female dogs (34/55.7%) than in male dogs (27/44.3%). The prevalence of infestation varied in each age group with dogs under 6 months old having the highest infestation frequency (48, or 78.7%), whereas dogs over 25 had the lowest incidence (6, or 9.8%). As the rainy season progresses, the prevalence of this illness drops gradually, with October seeing the lowest rate. It peaks in June, affecting 27.87% of all the animals examined. Among all canines, 18 (29.50%) were used as pets; the lowest prevalence was exhibited by 1 (1.63%) in the case of guard and hunting dogs. The breed that is least afflicted, with only 2 recorded occurrences, is the Chow chow, whilst German shepherd breeds (26.20%) are the most prone to this ailment. The possibility of this parasite spreading to humans through animals is a major worry for hunters, breeders, and pet owners in Ilorin and around the nation.

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Cordylobia; furuncular myiasis; Ilorin; incidence; risk factors

INTRODUCTION

The infestation of vertebrates (people and animals) by the larvae of a double-winged insect belonging to the order Diptera is known as myiasis (Solomon *et al.,* 2016). The name "myiasis" comes from the Greek word myia, which means "to fly" (Robbins and Khachemoune, 2010).

The tumbu fly is a large, yellow-brown insect that is 6–12 mm long and feeds on plants, animal excrement, and rotting carcasses. Female flies deposit 100–300 eggs on moist soil or clothing. Larvae are sensitive to vibration and heat, yet eggs can survive for several weeks in a humid environment (How *et al.,* 2017). Larvae of *C. anthropophaga* emerge after 8–12 days of piercing undamaged skin and growing within subcutaneous tissues (Song *et al.,* 2017). Furthermore, larvae swiftly adhere to and penetrate the skin. Pain, "prickly heat," anxiety, and insomnia are frequently reported as the initial symptoms by patients. Painful, subcutaneous, exudative nodules emerge from single or clustered inflammatory papules within a week of the onset of cutaneous symptoms (Sivelli *et al.,* 2015). For households who depend on dogs for hunting or security, untreated infestations in dogs can result in secondary bacterial infections, systemic sickness, and financial losses (Mutinda *et al.,* 2022). According to Mutinda *et al.* (2022) and Suarez *et al.* (2018), risk variables including breed susceptibility, age (puppies <6 months), and outdoor living conditions make the burden even more severe. Despite these ramifications, Nigeria lacks preventative

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measures or focused surveillance for canine myiasis. This is indicative of a larger disregard for zoonotic parasite illnesses in low-resource environments (Ogbalu *et al.,* 2013; Jesuyajolu, 2022).

Myiasis can be categorized using two different approaches: clinical classification and parasitological classification. Three types of myiasis are recognized in parasitological classification: facultative myiasis, which involves both dead and living host tissue, obligatory myiasis, which requires live host tissue, and accidental myiasis, in which eggs and larvae are inadvertently ingested and multiply in host tissues and organs (Hall *et al.,* 2016). The affected body part determines the clinical classification, such as cutaneous, gastrointestinal, nasopharyngeal, or urogenital (Sunny *et al.,* 2016). Moreover, furuncular, migratory, or wound myiasis are the three main clinical presentations of cutaneous myiasis (Francesconia and Lupi, 2012).

According to Choe *et al.* (2016), the most frequent cause of travel-associated myiasis infestation is furuncular myiasis. Worldwide, different cases of furuncular myiasis have been linked to larvae of *Cordylobia anthropophaga*, *Cordylobia rhodani*, *Dermatobia hominis*, *Cuterebra* spp., *Wohlfahrtia vigil*, and *Wohlfahrtia opaca* (Patterson *et al.,* 2014). Throughout Sub-Saharan Africa, *Cordylobia anthropophaga* (Blanchard, 1872) is the endemic tumbu fly. On the other hand, international travel to tropical regions has increased the prevalence of myiasis in non-endemic areas (Yunhua *et al.,* 2012). High humidity, unsanitary circumstances, and poverty are socioeconomic and environmental factors contributing to myiasis's prevalence in Nigeria (Ogbalu *et al.,* 2013; Wangia *et al.,* 2012). According to human studies, infants, children, and people working in jobs like farming and fishing are more vulnerable, which show infection rates in some areas surpass 82% (Ogbalu *et al.,* 2013). On the other hand, there is a lack of similar data on dog populations. Poor home hygiene and environmental management were connected to a 45% prevalence of cordylobiosis in Kenya (Mutinda *et al.,* 2022), which suggests that similar dynamics might exist in Nigeria. Due to factors like damp soil, poor waste management, and restricted access to veterinary care, dogs in rural and peri-urban Nigerian communities frequently reside in areas that are favorable to fly breeding populations. This may increase their exposure to *C. anthropophaga* eggs left on contaminated surfaces (Mutinda *et al.,* 2022; Suarez *et al.,* 2018). One Health approach linking veterinary and public health sectors is rare, and there is insufficient research on dogs as reservoirs for human myiasis. Meanwhile, there has been a surge in non-endemic locations with a higher incidence of myiasis due to increased international travel to tropical regions (Johnson *et al.,* 2016).

The infestation of *C. anthropophaga* is extremely dangerous for both people and animals, particularly in tropical regions where seasonal temperatures and unsanitary human behavior greatly exacerbate myiasis. Models predicting how warming temperatures or altered rainfall patterns could affect future infestation rates are absent. Several reports on travel-related cases among returning visitors from endemic areas have also been made due to the Western world's propensity for travel (Afifi *et al.,* 2015; How *et al.,* 2017; Wangia *et al.,* 2012). Therefore, this study aims to fill this knowledge gap by determining the risk factors and examining the prevalence of furuncular myiasis in dogs in Ilorin, Kwara state, Nigeria. The results of combining epidemiological data with socioeconomic and environmental factors will guide integrated control strategies, improving public health and veterinary outcomes in areas where *C. anthropophaga* is endemic.

MATERIALS AND METHODS

Study Design

Using a cross-sectional survey design that employs non-probability sampling techniques, 268 clinically ill dogs were screened, and with focus on those exhibiting the typical furuncular lesions with a central punctum were conveniently sampled from August 1, 2021, to October 31, 2021, from four major veterinary clinics in Ilorin, Kwara State, Nigeria (Aromokeye Veterinary Clinic, Kwara State Veterinary Clinic, Harmony Veterinary Clinic, and Animal plus Veterinary Clinic). Additionally, biodata of reported cases of furuncular myiasis from the listed clinics between May 1, 2021, and October 31, 2021, were gathered.

Study Area

Kwara State's capital, Ilorin, served as the sample collection site. With a population of over 908,490, Ilorin is the seventh-largest city in Nigeria as of 2016. It is situated in the country's north-central region, Nigeria (Fig. 1), near the coordinates 8°30'N 4°33'E. It is the home of numerous Nigerian tribes, including the Yoruba, Fulani, Hausa, and Nupe. There are also many foreigners from Ghana, Niger, Chad, Benin, Mali, and other African nations. People travel widely within the state capital for a variety of reasons, both within and between states (National Bureau of Statistics, 2016; Ola-Fadunsin *et al.,* 2019).

The main professions of the local people were agricultural farming, raising animals, weaving, leathering, ceramics, and small-scale trading. A densely forested savannah characterizes the vegetation. With an annual rainfall of 750-1250 mm, the rainy season lasts from April to November. The wettest month is June through October, with a respite in August in between. While the year-round high-temperature peaks in February and April remain high throughout. Similar to other fast-expanding urban and peri-urban areas, environmental sanitation is inadequate. Because of this, human habitations are more vulnerable to various myiasis infestations because of the favorable conditions, an abundance of food, breeding grounds, and shelter that attract a large number of flies, rats, and wandering animals (Kwara State Diary, 2012).

Ethical Approval

Before the study started, ethical approval of the guiding principles and protocols for animal use was obtained from

the University of Ilorin Committees on Animal Use and Care. UERC/FVM/2021/013 is the approval reference. Also, all dog owners, veterinarians, and relevant authorities gave their informed approval.

Sample Size Determination

In estimating the minimum sample size for this study, 77.5% prevalence rate obtained by Ogo *et al.* (2009) for *Cordylobia* spp infestation on dogs in Jos, Plateau state was adopted. The formula of Thrusfield (2007) was used for determining the sample size.

$$N = \frac{Z^2Pq}{d^2}$$

Where:

N = minimum sample size
P = Expected prevalence rate
d = Desired absolute precision of 5% (0.05)
q = Complementary probability (1-P)
Z = Appropriate value for the standard normal deviate set at 95% confidence interval (1.96).

Therefore:

$$N = \frac{1.96^2 \times 0.775 \times 0.225}{0.05^2} = \frac{0.9604}{0.0025} = 267.95 = \mathbf{268}$$

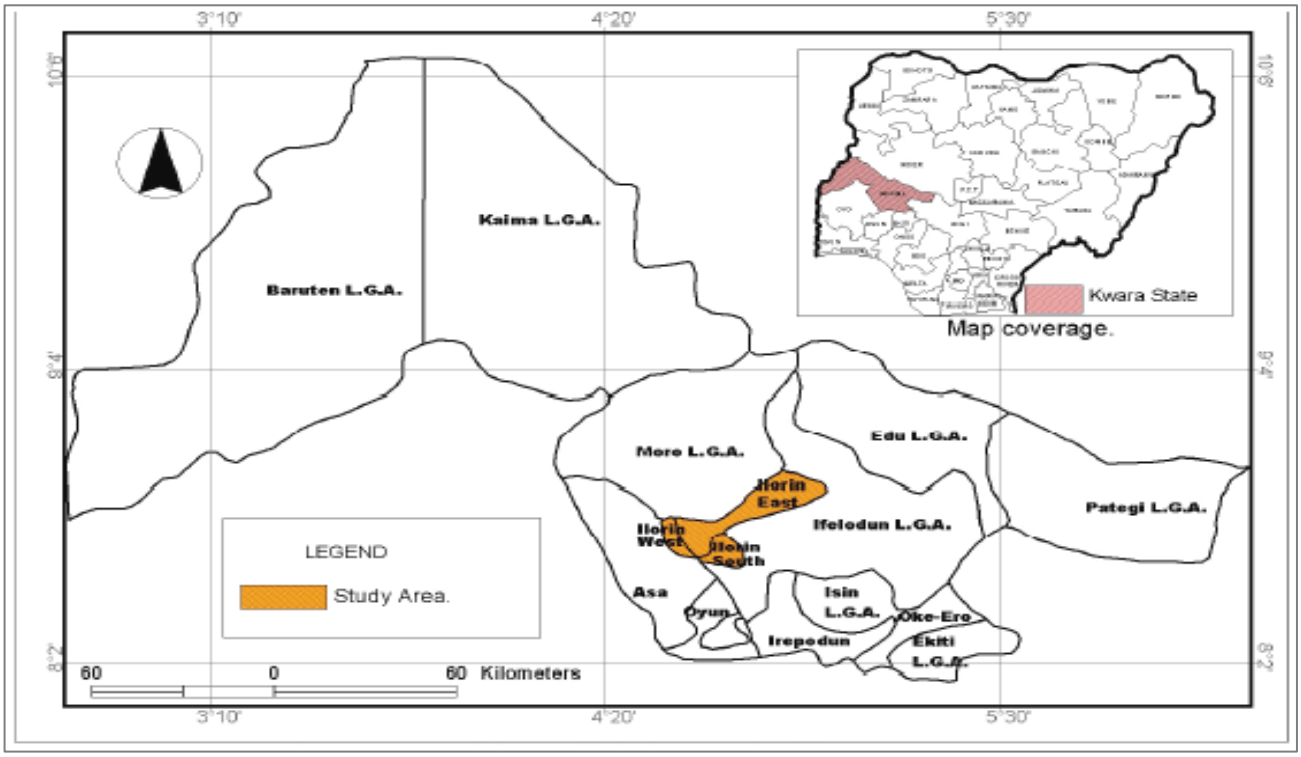

Figure 1: Map showing the Ilorin Metropolis. Insert map shows the location of Kwara State in Nigeria (Joseph et al., 2016).

Sample Collection

All reported canines displayed clinical furuncular lesions with a central punctum during the study period. Diagnostic lesions in dogs with furuncular myiasis might be single or several erythematous nodules with a central opening that occasionally reveal the larva's posterior end. The larvae were gathered using forceps and removed from the furuncular lesion by applying a small amount of digital pressure at the base of the boil-like lesions. They were then placed in clearly labeled sample vials that contained 70% ethanol. The bottles were then kept in a transport cooler and transported to the Department of Veterinary Parasitology and Entomology, University of Ilorin, Kwara State, Nigeria.

Morphological Identification of the Larvae Extracted

In a petri dish, a few drops of water were introduced. Each preserved larva's spines and posterior spiracles were then observed under a stereomicroscope while positioned on a Petri plate. After collecting each of the larva's two posterior spiracles, the larvae were subjected to a series of ethanol grades (70%, 90%, and 100%), with a 10-minute break between each grade, to facilitate the proper fixing. After that, the fixed spiracles were submerged in xylene for ten minutes.

The posterior spiracle was placed onto a perfectly clean, grease-free glass slide after a drop of mordant was added to it. Next, the slide was covered with a spotless cover sheet. To fill the area and restrict the vacuoles when viewing, more mordant was introduced to the slide through the borders of the glass slide and the cover slip. The slide was left for a full day to mount the posterior spiracle. Using an x10 objective lens magnification to focus, the prepared slide was examined under a light microscope. For accurate posterior spiracle identification, it was then set to x40 of the objective lens magnification (Hall and Smith, 1993; Soulsby, 1982).

Data Analysis

Descriptive statistics were computed once the data were entered into the Microsoft Excel 2016 spreadsheet. Breed, sex, age, and purpose were the dogs' categorical variables and were expressed as a percentage. To examine any correlation between the categorical characteristics of the dogs in the sample (age, sex, breed, and risk factors like purpose and use) and the incidence of *C. anthropophaga*, the Univariate logistic regression analysis was employed. A significance level of $p < 0.05$ was used for these variables.

RESULTS

Macroscopic Identification

The larvae were grossly yellowish, cylindrical, 11-segmented larva measuring 6 x 2.9 mm. IX–XI were nearly barren, but segments III–VIII had many tiny black spines strewn throughout. The larvae were confirmed to be that of *C. anthropophaga* with its unique features, as shown in Figure 2a (Song *et al.,* 2017).

Microscopic Identification

Larvae were identified as the third larval stage of *C. anthropophaga* using standard identification keys (Fernández-Alvarez *et al.,* 2022; Hall *et al.,* 1993; Zumpt, 1965), based on their characteristic features, including the presence of three slightly serpentine slits on the posterior spiracular plates of the larva in Figure 2b.

The Univariate logistic regression analysis of the association between the incidence of *C. anthropophaga* larvae on dogs in Ilorin Metropolis, North Central, Nigeria, is shown in Table 1. *C. anthropophaga* infestation was more common in female dogs (55.74%, 34 dogs) than in male dogs (44.26%, 27 dogs), according to data gathered between May 1, 2021, and October 31, 2021. According to statistics, there was no significant difference in the occurrence of this infestation based on sex ($p>0.05$), with female dogs having a higher prevalence of infestation and females being 1.58 more likely to be infested compared to males.

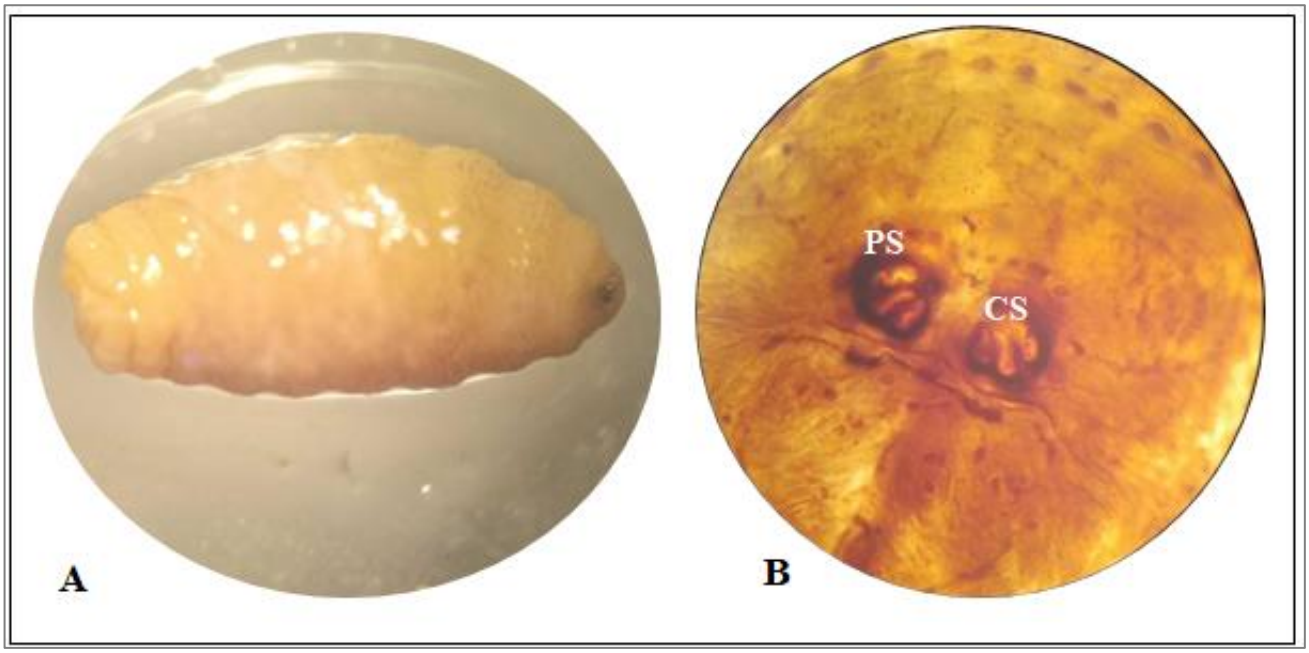

Figure 2. (A) Morphological appearance of *C. anthropophaga* larva. (B) Spiracles of *C. anthropophaga* under a light microscope (PS) posterior spiracle and (CS) three characteristic slits (x400 magnifications).

Dogs under the age of 6 months had the highest prevalence of *C. anthropophaga* myiasis in Ilorin, accounting for 31 (50.82%) of the total cases reported. Dogs between the ages of 6 months and 1 year had the second highest prevalence (17 (27.87%)), with dogs older than 2 years having the lowest prevalence of 6 (9.84%). The prevalence of *C. anthropophaga* infestation reduced with the increase in age, with dogs older than 2 years being 9.29 and 3.51 times more likely to be infested with *C. anthropophaga* compared to dogs of < 6 months old and 6 months – 1 year old respectively with this association being statistically significant ($p<0.05$).

Regarding the purpose of keeping dog(s), pet dogs had the highest prevalence 29.51% with a count of 18, while dogs kept for breeding and guarding recorded the lowest prevalence of 1.64% and a count of 1. There was no statistical difference in the occurrence of *C. anthropophaga* infestation in pet dogs compared to dogs raised solely for breeding and guard purposes respectively. The infestation of *C. anthropophaga* was 5.88, 25.00, 5.88, and 3.85 times more likely to occur in dogs kept for the purposes of hunting, breeding and guard, guard and hunting, and guard and pet respectively compared to pet dogs and the association was statistically difference with a p value that was less than 0.05.

The German shepherd dog was the most prone breed to this infestation when it came to incidence by breed, with 26.23% prevalence. The prevalences according to breeds of dogs were Caucasian (9 (14.75%)), Eskimo (7 (11.48%)), Indigenous Nigerian breed (7 (11.48%)), Pit

bull (7 (11.48%)), Boerboel (5 (8.20%)), Lhasa Apso (5 (8.20%)), Rottweiler (3 (4.92%)), and Chow Chow (2 (3.28%)). There was no statistically difference in the prevalence of *C. anthropophaga* infestation among dog breeds with a p value that was greater than 0.05.

Table 1. Univariate logistic regression analysis of the association between the incidence of *C. anthropophaga* larvae on dogs in Ilorin Metropolis, North Central, Nigeria.

Variables	Number infested with *C. anthropophaga* (%)	OR (95% Cl)	p-value	χ^2-value
Gender				
Female	34 (55.74)	1.58 (0.77, 3.26)	0.21	1.61
Male¥	27 (44.26)	1.00		
Age				
< 6 months	31 (50.82)	9.29 (3.61, 26.94)	<0.01€	24.24
6 months – 1 year	17 (27.87)	3.51 (1.30, 10.44)	0.01€	6.48
> 1 year – 2 years	7 (11.48)	1.19 (0.36, 3.99)	0.78	0.09
> 2 year¥	6 (9.84)	1.00		
Purpose of keeping dog(s)				
Breeding	12 (19.67)	0.59 (0.25, 1.36)	0.22	1.59
Guard	16 (26.23)	0.85 (0.38, 1.89)	0.69	0.16
Hunting	4 (6.56)	0.17 (0.05, 0.51)	<0.01€	10.87
Breeding and guard	1 (1.64)	0.04 (<0.01, 0.24)	<0.01€	18.02
Guard and hunting	4 (6.56)	0.17 (0.05, 0.51)	<0.01€	10.87
Guard and pet	6 (9.84)	0.26 (0.09, 0.70)	0.01€	7.469
Pet¥	18 (29.51)	1.00		
Breeds of dogs				
German shepherd	16 (26.23)	2.72 (0.04, 7.65)	0.04€	4.34
Caucasian	9 (14.75)	1.33 (0.45, 4.03)	0.61	0.29
Eskimo	7 (11.48)	1.00 (0.32, 3.17)	1.00	0.00
Pit bull	7 (11.48)	1.00 (0.32, 3.17)	1.00	0.00
Boerboel	5 (8.20)	0.69 (0.19, 2.37)	0.56	0.37
Lhasa Apso	5 (8.20)	0.69 (0.19, 2.37)	0.56	0.37
Rottweiler	3 (4.92)	0.40 (0.08, 1.61)	0.21	1.73
Chow Chow	2 (3.28)	0.26 (0.04, 1.25)	0.10	3.00
Indigenous Nigerian breed¥	7 (11.48)	1.00		

OR = Odd ratio; CI = Confidence interval; χ^2 = Chi square; ¥ = reference category; € = Significant at p < 0.05.

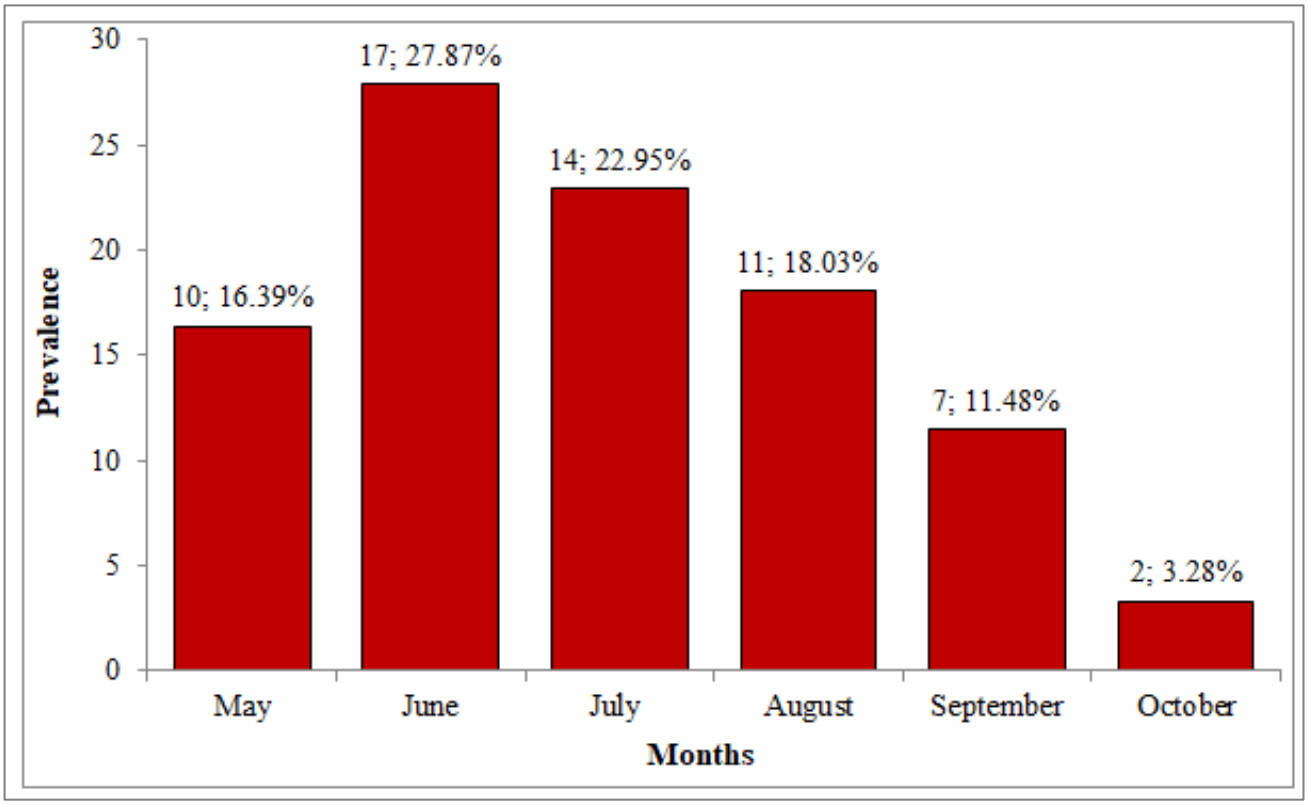

Figure 3. Monthly counts and prevalence of *C. anthropophaga* larvae on dogs in Ilorin Metropolis, North Central, Nigeria.

The monthly prevalence of *C. anthropophaga* infestation among dogs in the study area showed that the occurrence was highest in June (17, 27.87%) and lowest in October (2, 3.28%). The counts and prevalences in the other months were 14 (22.95%), 11 (18.03%), 10 (16.39%), and 7 (11.48%) for July, August, May, and September respectively. There was a statistical difference in the monthly prevalence of *C. anthropophaga* infestation among dogs with a p value of 0.01 and a chi square value of 16.39 (Figure 3).

DISCUSSION

Our results indicate that, for the period from 1 August 2021 to 31 October 2021, and from 1 May 2021 to 31 October 2021 for the data recovered from their case record book, *C. anthropophaga* was successfully identified in 100% of the larvae retrieved from dogs. The four veterinary clinics in Ilorin provided a handy sample of clinically unwell dogs for a cross-sectional survey that included 268 dogs. Of those, 61 (22.76%) tested positive for the typical furuncular lesions with a central punctum. This outcome aligns with two distinct studies carried out by Ogo *et al.* in Jos Metropolitan, a Plateau State municipality (2005; 2009). Given that the Plateau is a North Central state, it shares a geopolitical region with Kwara State. Even dogs from different places and those employed for diverse purposes, such as breeding, hunting, and more, were infested by *C. anthropophaga* exclusively, although host-specificity for myiasis-causing flies has not been revealed. Because of this, dogs in the Ilorin metropolis may be more likely to contract *C. anthropophaga*.

Furthermore, our results show that pet dogs account for the greatest number of instances (29.50%). This result contradicts the findings of Rutland *et al.* (2017), who claimed that hunting dogs have the highest inclination. Our research showed that the infestation rate of hunting dogs was 1.63% lower. This discrepancy may arise from owners using home medicines failing to notify veterinary hospitals in the city of Ilorin about incidences of furuncular myiasis.

It was discovered that furuncular myiasis affects both sexes to varying degrees. However, as this was shown to be statistically significant ($P<0.05$), it is noteworthy that 56% of the cases documented involve female dogs, suggesting sex susceptibility. This result aligns with the findings of Ogo *et al.* (2009), who reported a 58.95% prevalence in female dogs; however, Abebe (2017) found no statistically significant difference in sex predilection in his investigation.

In addition, this study discovered that ≤6-month-old dogs had the highest frequency of infestation (50.82%), which is comparable to the 68.90% prevalence seen in a retrospective study conducted by Ogo *et al.* (2005), which reported a prevalence of 77.50% on young dogs with myiasis. Due to their thin, sensitive skin, which is more suited for larval growth, young dogs may have an increased incidence of this condition (Mutinda *et al.,* 2022).

Moreover, we found that the largest level of infestation by *Cordylobia* spp larvae occurs during June's heavy rains, and the lowest level occurs around October. Six cases of infestation were reported from May to July, compared to three cases from August to October, according to Orfanou *et al.* (2011). The findings of Ogo *et al.* (2005), who reported a high prevalence of infestation of 75.80% between April and October, also coincide with it. The increased fly activity that occurs in Nigeria before the start of the rainy season is the likely cause of these observations.

While Ola-Fadunsin *et al.,* 2019 and Omudu *et al.,* 2010 reported high prevalence in local and cross breeds due to the special care and attention given by their owners due to their cost of purchase, the high incidence or prevalence recorded in exotic breeds in this study is in contrast to those findings. However, our study concluded that the high prevalence observed was caused by the local dog owners' attitude toward reporting the majority of these cases to a nearby veterinary clinic. As a result, they prefer to treat themselves partly because they assume the cost of services and are unaware of the zoonotic risks associated with *C. anthropophaga*. To the best of our knowledge, this is the first study conducted in Ilorin on dogs infested with *C. anthropophaga*. To end this crippling illness in humans and animals, there is an urgent need for disease reporting, public health education, and timely surveillance.

CONCLUSION

The study's conclusions suggest that *C. anthropophaga* is the main reason dogs in the city of Ilorin get furuncular myiasis. As *C. anthropophaga* has been linked to human cutaneous myiasis in the Ilorin metropolis, Edungbola (1982) also found that *C. anthropophaga* infestations are important for public health and should be given the attention the government and health professionals need. Additionally, this research demonstrates a culture that maintains dogs under various forms of management, with less emphasis placed on risk factors and the implications for public health.

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CONFLICT OF INTEREST

No conflict of interest

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