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Animal Tungiasis in the endemic areas of Badagry Local Government Area of Lagos State, Southwestern Nigeria

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Abstract

Tungiasis is prevalent in many resource-poor communities in sub-Saharan Africa though poorly studied. Tungiasis in animals increases greater parasitic load in humans. Households across 18 endemic communities of Badagry Local Government Area, Lagos State were surveyed. Clinical examination of 1020 animals owned by the 188 sampled households was carried out by inspection of their bodies for the characteristic lesions. Intensity of the *Tunga* infestation were classified as light, moderate and heavy. The lesions were also staged based on Fortaleza Classification and extracted with the owners' permission. Out of 1020 animals sampled, including 492 and 528 during the wet and dry seasons, respectively, the total prevalence of tungiasis infestation was 47 (4.6%) for both seasons. Dogs 25 (53.2%) were the commonest infected animal encountered. Infected animals were significantly (p=0.03) in the dry season 29(5.5%) compared to the wet season 18(3.7%). The embedded fleas were mostly located around the eyes and ears of the animals. Out of the infested animals, 55.3% had light infestation and severity of the infection were more in the dry season, however the difference was not significant (p>0.05). Reducing its zoonotic potentials requires removing obstacles to its management. The One Health principles should be followed for effective management.

Introduction

Animal tungiasis is caused by the penetration of female sand flea, *Tunga* species, into the skin of animals during its blood feeding activities. This ectoparasitic infestation is highly prevalent in many resource-poor communities in sub-Saharan Africa, Latin America and the Caribbean. *Tunga penetrans* infects a wide range of domestic, peri-domestic and wild mammals (Mutebi *et al* 2015). Animals found within and around houses, such as dogs, cats, pigs and rodents, play crucial roles as reservoir hosts for this flea (Harvey *et al* 2017). Human tungiasis frequently coexists with animal infections in many endemic populations, making it a common One Health concern (Mutebi *et al* 2021. It has been established that these animals worsen the *Tunga* infestation problem by heightening the risk of human infection in endemic communities (Mutebi *et al* 2015). As in humans, most sand flea infections in animals are localized on the distal areas of the legs. However, other body parts, which contact or are close to the ground such as mammary glands, snout, perineum, muzzle, tail, genital areas and abdomen may also be affected (Mutebi *et al* 2017; Harvey *et al* 2021). Apart from harbouring this infection that can affect humans, both domestic and wild animals experience significant morbidity and health issues when they are infested (Mutebi *et al* 2018). The significance of each animal species in the epidemiology of human tungiasis differs across different endemic regions (Mutebi *et al* 2015). Pigs appear to be the primary reservoirs in West Africa, whereas in Brazil, cats, dogs, and rodents are commonly identified as the frequently infected hosts (Gitau *et al* 2021).

Five major factors that have been linked to the occurrence and maintenance of tungiasis infections in Brazilian endemic communities over the past 20 years. They include poor health, a lack of control and neglect in the management of domestic and synanthropic animal populations, poor personal hygiene habits, a lack of information from the general public and related professionals, and a lack of recognition of tungiasis as a disease (Harvey *et al* 2021). There have been reports of infections in fishing communities (Pilger *et al* 2008; Heukelbach *et al* 2004; Ogbomoiko *et al* 2008; Otubanjo *et al* 2016), urban slums (Heukelbach *et al* 2004) and in rural and semi-rural communities (Muehlen *et al* 2006; Harvey *et al* 2017).

Till date, very few studies have been conducted to describe the epidemiology of animal tungiasis in the endemic areas of Nigeria. To fill this gap, this study is aimed at identifying the major animal reservoirs and estimating the prevalence of *T. penetrans* in rural endemic communities of Badagry, a Local Government Area in Lagos, Nigeria.

Materials and methods

Study area

population and sampling

A longitudinal study was carried out in eighteen communities located in Badagry from August, 2021 to April, 2022 covering the wet and dry seasons. The communities surveyed included: Aivoji, Ajido, Jegeme, Agbovipe, Agadangba, Joforo, Epeme, Okun mopa, Kpakor, Asakpo, Ilaje 1. Yovoyan, Temidire (Ilaje 11), Tosuvi, Akorokodji, Afowo, Kweme and Tafi. Badagry was purposively selected because of the high prevalence of human tungiasis reported by various researchers (Ade-Serrano and Ejezie, 1981; Ugbomoiko *et al* 2007; Otubanjo *et al* 2016 and Heukelbach *et al* 2021) and also confirmed during the preliminary survey.

Badagry, a Local Government Area in Lagos State (Figure 1), houses a population of 241,093 according to the 2006 Census. The primary occupations of the people include fishing and farming, with some engaging in office work in the township areas of Badagry. The predominant ethnic groups among the inhabitants are the Yoruba and Egun.

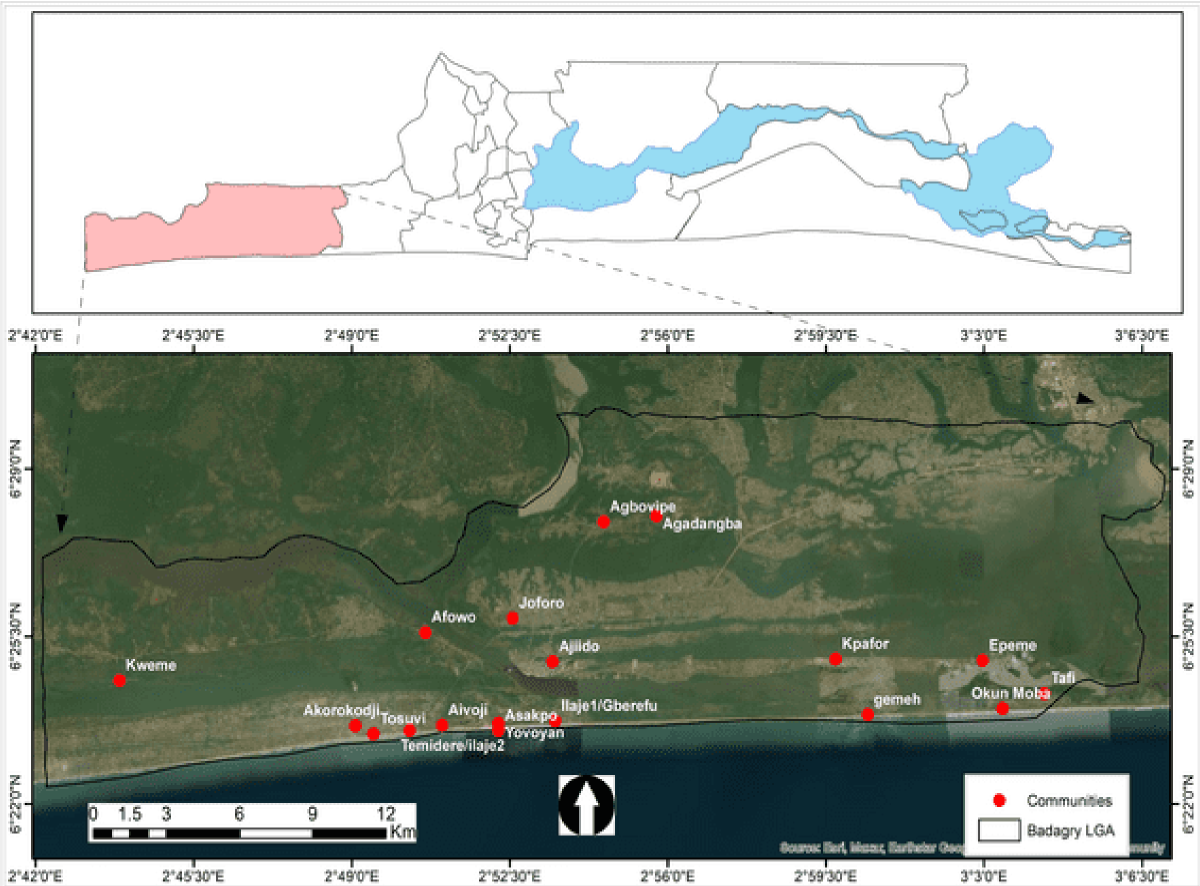

Figure 1. Map of Badagry Local Government Area showing the sampling areas

The survey consisted of clinical examination of 1020 animals owned by the sampled population who were animal owners in each of the eighteen communities and application of a semi-structured questionnaire to 188 households based on ownership of animals. Inspection of animals was done by observation of the bodies of animals especially the lower abdomen, paw, digits and tail for characteristic lesions of *Tunga* flea. The presence of single and clustered lesions or "white patch with a black dot" were documented. Intensity of the infestation were classified as light (1-5 lesions), moderate (6-30 lesions) and heavy (>30 lesions) (Muehlen *et al* 2006) and were documented. The lesions were also staged based on Fortaleza Classification (Eisele *et al* 2003). Extraction of fleas was done on infested animals based on the consent of their owners. Such excised fleas were preserved and transported to Nigeria Institute of Medical Research (NIMR), then stored at low temperature. Extraction of DNA for molecular analysis to identify the fleas was carried out using the method described by Luchetti *et al* (2005).

Data analysis

The Statistical Package for Social Scientists (SPSS) was used for data analysis. Quantitative data extracted from questionnaires were computed into SPSS, the frequencies and means of the data obtained were determined. Data on prevalence were analyzed using Chi square.

Ethical Considerations

The study proposal was submitted to the ethical committee at the Nigeria Institute of Medical Research (NIMR) for both institutional scientific review and ethical endorsement. This study was assigned the IRB approval number IRB/21/053. Further approval was secured from the Badagry Local Government Area Public Health Board, alongside seeking permission from the community heads of study sites. Oral as well as written consent were also obtained from household heads after explaining the purpose of the study to them.

Results

One thousand and twenty individuals in various household were interviewed in the eighteen selected communities, out of which more than half of the population (63.2%) possessed various domestic animals. Animals encountered in the order of their frequency included chickens, dogs, cats, goats, ducks, pigs, cattle and guinea fowls (Table 1).

Animal infestation was found among 47(4.6%) of the respondents' animals in both wet and dry seasons, dogs 25(53.2%) closely followed by chickens 21(44.7%) were the commonest infected animals encountered (Table 2). Most of the embedded fleas were located around the eyes and ears of the animals (Plate 1). Out of the infected animals, 26 (55.3%) had between one and five lesions, 21(44.7%) had between six and thirty lesions and no heavily infested animal was encountered.

More, 29(5.5%) animals were infected during the dry season as compared 18(3.7%) in the wet season. There was statistically significant difference ($p<0.05$) in the animal infection obtained between the wet and dry season (Table 3).

Ilaje 1/Gberefu Community had the highest number of infested animals 14(30%) (Table 4) while 4 out of the sampled communities namely Tosuvi, Kweme, Ajido and Agbovipe, had no record of animal infestation during the survey (Figure 2).

Severity of the lesions on the infected animals were more in the dry season when compared to the wet season as shown on (Table 5), however the difference observed was not statistically significant ($p>0.05$). There was no significant difference statistically in the number of extracted fleas between wet and dry season (Table 6).

Table 1: Types and numbers of animals possessed by respondents

Variables	Frequency N = 1020	Percentage (%)
Possession of domestic animals		
Yes	644	63.2
No	375	36.8
Type of animal		
Dog	225	34.9
Chicken	433	67.2
Duck	67	10.4
Goat	103	16.0
Pig	39	6.1
Cattle	11	1.7
Cat	128	19.9
Guinea fowl	2	0.3

Table 2: Prevalence, localization and classification of animal tungiasis infestation

Variables	Frequency	Percentage
Animal tungiasis status		
Infected	47	4.6
Non-infected	973	95.4
Type of infected animal		
Chicken	21	44.7
Dog	25	53.2
Cat	1	2.1
Location of skin lesions		
Lower abdomen	9	19.1
Nose	4	8.5
Leg/Paw/pads	4	8.5
Eyes	15	31.9
Ears	15	31.9
Severity of infestation/number of viable lesions		
Light (1-5 lesions)	26	55.3
Moderate (6-30 lesions)	21	44.7
Staging of lesions		
Dark brown to black spot 3-10mm surrounded by a reddened or swollen area	9	19.1
Red brown spot with a diameter between 1 and 2mm	38	80.9
Extraction of adult flea on animal		
Yes	18	38.1
No	29	61.7

Table 3: Comparison of prevalence of animal tungiasis between wet and dry season

Variables	No. Examined	Animal tungiasis status	
		Infected (%)	Uninfected (%)
Wet Season	492	18(3.7)	474(96.7)
Dry Season	528	29(5.5)	499(94.1)
Total	1020	47(4.6)	973(95.4)
	$\chi2$ =3.975, df = 1, p=0.032*		

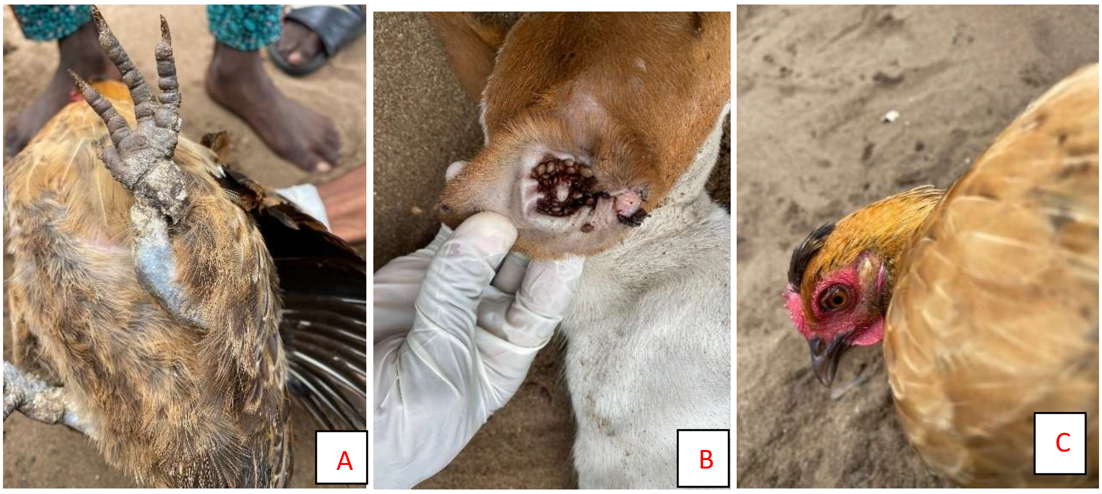

Plate 1. Infected parts of different animals: A- leg of a chicken, B- ear of a dog and C- eye of a chicken

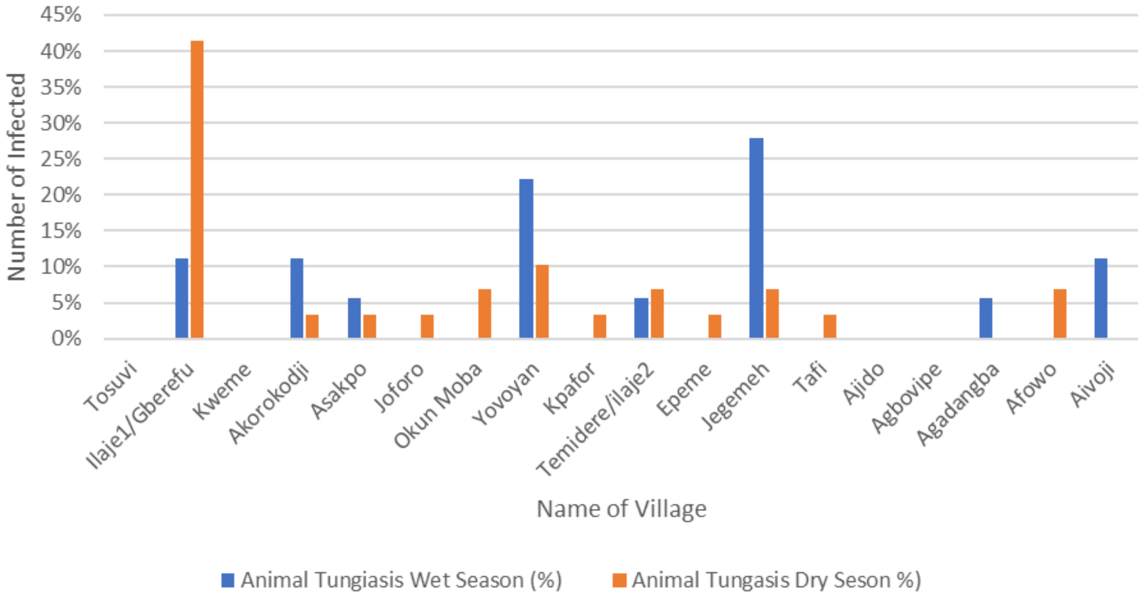

Figure 2. Seasonal and spatial variations in animal tungiasis status in the study area

Discussion

Tungiasis in domestic animals, caused solely by *T. penetrans*, has been documented in several African countries such as Uganda, Kenya, Tanzania, Nigeria, Ethiopia, Cameroon, Democratic Republic of Congo, and Saó Tomé Island (Mutebi *et al* 2021). During the course of this survey, a prevalence of 4.6% animal tungiasis was recorded among the animal rearing households in both wet and dry seasons. More animals were found infected during the dry season than the wet season and the difference obtained was found to be statistically significant (p=0.03). Animal tungiasis was detected in fourteen of the eighteen communities sampled, with dogs closely followed by chickens being the animals with the highest number of infections. Ugbomoiko *et al* (2008) identified pigs, closely followed by dogs as the major reservoirs of infection in their study in Erekiti, a rural community of Badagry LGA. In Uganda, tungiasis was detected in pigs, dogs, goats and a cat, respectively, in their order of significance by Mutebi *et al* 2015, with pigs also having the highest prevalence (34.8%). In this same survey, animal tungiasis was detected in nine of the ten villages they surveyed with an overall prevalence of 26.3% out of the 236 households.

In this current research, infestation was found on dogs, chickens and a cat with dogs having the highest prevalence of the infection (53.2%) closely followed by chicken (44.7%). Very few pigs were encountered roaming freely in the community during the course of the survey and none was found infected. Pigs, dogs, cats and domestic ruminants have been reported to harbor high intensities of sand fleas in endemic communities (Mutebi *et al* 2021). Dogs and cats are the most common animal reservoirs of *Tunga penetrans* in South America with a reported prevalence of 30.9% - 67.1% in dogs and 32.4% - 49.6% in cats (Heukelbach *et al* 2004). In Brazil, dogs and cats seem to be the most important reservoirs as

Table 4: Seasonal distribution of animal tungiasis across sampled villages in Badagry

	Animal tungiasis status				Total no infected (%)
	Wet Season		Dry Season		
Name of Village	No examined	No infected (%)	No examined	No Infected	
Tosuvi	30	0(0)	30	0(0)	0(0)
Ilaje1/Gberefu	41	2(11.1)	48	12(41.4)	14(29.9)
Kweme	31	0(0)	30	0(0)	0(0)
Akorokodji	30	2(11.1)	30	1(3.4)	3(6.4)
Asakpo	30	1(5.6)	13	1(3.4)	2(4.3)
Joforo	31	0(0)	30	1(3.4)	1(2.1)
Okun Moba	30	0(0)	37	2(6.9)	2(4.3)
Yovoyan	36	4(22.2)	30	3(10.3)	7(14.9)
Kpafor	18	0(0)	22	1(3.4)	1(2.1)
Temidere/ilaje2	16	1(5.6)	32	2(6.9)	3(6.4)
Epeme	20	0(0)	30	1(3.4)	1(2.1)
Jegemeh	33	5(27.8)	31	2(6.9)	7(14.9)
Tafi	15	0(0)	15	1(3.4)	1(2.1)
Ajido	30	0(00	30	0(0)	0(0)
Agbovipe	30	0(0)	30	0(0)	0(0)
Agadangba	30	1(5.6)	30	0(0)	1(2.1)
Afowo	30	0(0)	30	2(6.9)	2(4.3)
Aivoji	11	2(11.1)	30	0(0)	2(4.3)
Total	492	18(3.7)	528	29(5.5)	47(4.6)

Table 5: Comparison of severity of lesions on animal between wet and dry season

Variables	No. Examined	Severity of viable Lesions	
		Light (1-5)	Moderate (6-30)
Wet Season	18	13(72.2)	5(27.8)
Dry Season	29	13(45)	16(55.2)
Total	47	26(55.3)	21(44.7)
	$\chi2$ =1.991, df = 1, p=0.574		

Table 6: Comparison of the population of extracted adult flea on animals in the wet and dry season

Variables	No. Infected	Extraction of adult flea (animal)	
		Extracted	Not Extracted
Wet Season	18	5(28)	13(72.2)
Dry Season	29	13(44.8)	16(55.2)
Total	47	18(38.3)	29(61.7)
	$\chi2$ =3.071, df = 1, p=0.080		

documented by several researchers such as Heukelbach *et al* (2004), Muehlen *et al* (2006), Pilger *et al* (2008) and Harvey *et al* (2017, 2021). Mutebi *et al* (2018) observed from their findings in Uganda that pigs and dogs are the commonest *T. penetrans* animal hosts known to animal owners.

Dogs could have significant epidemiological significance due to their potential role in spreading flea eggs over a broader area compared to pigs. The identification of tungiasis in a lone cat in the present survey reinforces earlier observations suggesting that cats might serve as reservoirs *for T. penetrans* (Mutebi *et al* 2015). Heukelbach *et al* (2004) found prevalence rates of tungiasis comparable in cats and dogs to those in the human population. They noted that tungiasis occurs mostly on the pads and in rare cases on the muzzle of dogs while lesions are confined to the feet of cats. Sand fleas exhibit a preference for infiltrating soft and well-vascularized lower body parts, leading to a majority of lesions in infected animals being found on their limbs. This localization of sand fleas on the feet is not exclusive to animals; it also applies to most susceptible humans. This behaviour has been attributed to the small size and limited jumping ability of sand fleas (Mutebi *et al* 2016). However, in this present survey, infestation occurred more frequently around the eyes and ears of the infected animals. This could be due to the animals' activities, which involve these body parts coming into regular contact with the ground, particularly while they are sleeping or searching for food.

Studies conducted by other researchers have depicted domestic animals as important reservoirs of *Tunga penetrans* and significant in human infection (Mwangi *et al* 2015; Mutebi *et al* 2023). This is because of the role these animals may play in the spread of this ectoparasite in the area. Since most individuals are unaware of how animals might exacerbate tungiasis, most jigger-infected populations freely engage with these animals without realizing the risk of exposure.

Infestation of animals in this study revealed that 55.3% of the infested animals had between one and five lesions, 44.7% had between six and thirty lesions and no heavily infested animal was encountered. Mutebi *et al*

(2016) also documented a similar result from rural Uganda community with only two of the dogs they examined having 5–8 lesions while the other 18 dogs they examined had light infections (1–4 lesions). Ugbomoiko *et al* 2008 observed that intensity of infestation was higher in pigs and dogs than in house rat in their tungiasis research on domestic animals and rodents in Erekiti community of Badagry. A positive association has been observed between the animal and human infection intensities. The likelihood that a household member will get tungiasis increases if the family has an infected dog or cat (Saboyá-Díaz *et al* 2022).

The amount of blood consumed by a female sand flea during stages 1 to 3 of its life cycle remains unknown. However, it is plausible possible that with a substantial parasite load and the cumulative burden of parasites throughout the year, infected animals could experience anemia (Mutebi *et al* 2016). Published literature indicates that tungiasis has a considerable impact on growth rate, limb abnormalities, and subsequent bacterial infections of animals despite the fact that its economic significance in animal production has not been analytically established (Gitau *et al* 2021).

Conclusions

In the sampled communities of Badagry, characterized by rural features, the presence of sand flea infestation amongst their animals was confirmed with *Tunga* as an ectoparasite mostly found among dogs, thus potentially serving as the major animal reservoir. The prevalence in animals was as high as 30% in certain places in the sampled areas of Badagry communities with higher infection during the dry season. However, the poor state of the environment and living conditions of the inhabitants coupled with the neglect of *Tunga* infestation may serve as barrier for its control. A reduction of prevalence will decrease the intensity of infestation, secondary infection and associated morbidity, this will in turn drastically reduce the prevalence of infection in humans. Reducing its zoonotic potentials requires removing obstacles to its management and the One Health principles should be followed for effective management.

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Conflict of Interest

Authors declare that no conflict of interest exist.

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