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Abstract

The availability of reliable estimates of dog populations is crucial in developing a control strategy for canine rabies in developing countries. The frequent roaming of dogs around Ahmadu Bello University (ABU) campus coinciding with reported cases of rabies outbreaks informed this study. The aim was to determine dog population size in ABU and Bomo, a village 500 meters away from Area C residential area of ABU main campus. From December, 2013-March, 2014, a questionnaires study was carried out in selected 510 households including urban (210 in ABU) and rural (300 in Bomo village) areas of Kaduna state. The questionnaire solicited information about dog's usage, age, sex, anti-rabies vaccination status, differences in population density, frequency distribution and factors contributing to straying of owned dogs. Our findings showed that urban households (79 in ABU) owned dogs more than rural households (22 in Bomo village) which was significant ($P<0.05$, χ^2). There was no significant difference between the numbers of dog with up to date anti-rabies vaccination recorded in urban (41%) than in rural areas (9.1%). Male to female ratio was higher in rural (5.8:1) than in urban areas (2.9:1). Dogs were used for security purpose in both urban (82.3%) and rural areas (95.5%). Adult dogs dominated both urban (68.8%) and rural (65.9%) dog populations ($P<0.05$, χ^2). The dog-to-human ratio was higher in urban (1:7.6) than in rural areas (1:219.5). Similarly, the dogs' abundance in the urban areas was five times higher than that of the rural areas. The low anti-rabies vaccination status of dogs, abundance of male and older dogs over female and younger ones, low restriction rate of dog movements constitute a great public health risk to human populations in terms of dog bites and rabies outbreaks.

Keywords: Dog, Ecology, Nigeria, Rabies, Vaccination

Introduction

Dog population dynamics have major impacts on the effectiveness of rabies control strategies. An understanding of the domestic dog ecology has been recognized as central to the design of effective rabies control programmes (Cleaveland *et al*., 2006). Dog population management is also key in controlling outbreaks of zoonotic diseases (FAO, 2014). In Nigeria, the 2006 census estimated that there were about 2-million dogs in Nigeria, of which many were either domesticated or stray dogs. Dogs are known to be intimately dependent on humans

for food and shelter (Brooks, 1990), meaning dog population can be correlated in size and distribution to human populations. Domestic dogs are the main reservoir host for rabies in developing countries (Cleaveland *et al.,* 2006). This enhances persistence of the rabies virus in the local dog population (Bingham, 2005). Between 24,000 - 70,000 people die of rabies in Asia and Africa each year (Knobel *et al.,* 2005) and the domestic dog is the main source of exposure and primary vector of this important human disease (Wandeler *et al.,* 1993). Rabies has more economic impact in the developing world, where thousands of people die from rabies annually, and millions receives costly post exposure prophylaxis (WHO, 2004). More than 99% of human deaths from rabies occur in Africa and Asia (WHO, 2004), children less than 15 years old in Africa and Asia are mostly affected (Knobel *et al.,* 2005; Fooks *et al.,* 2014). Fooks *et al.* (2014) attributed over 2 million disability-adjusted life years per year and loss of over $4 billion annually to rabies. The major constraints to effective rabies control are poor economic planning and logistics. This may also be partially connected to lack of technical know-how, personnel, poor infrastructure and inadequate resources, which hamper control programmes (Perry, 1993).

Stray dog populations may result from irresponsible dog ownership, where dogs belonging to individuals or families, are left entirely unsupervised or with partial restriction. Thus, planning control programmes may be difficult, requiring information on the size and population dynamics of dogs in particular locations (FAO, 2014). Studies on dog population and ecology have over the years provided veterinary public health officials with estimates used in planning rabies vaccination and control of internal and external parasites of dogs (Matter *et al.,* 2000; Omude *et al.,* 2010). Effective control of canine rabies can only be achieved where vaccination programmes are done following a good estimate of dog populations (WHO, 2004).

The high number of dogs observed to be roaming the ABU campuses informed this study. Recently, rabies outbreaks have been reported in and around the campus and there is a possibility of eliminating canine rabies as has been demonstrated in North America, Western Europe, Japan and many areas in South America (WHO, 2004). WHO expert's consultation on rabies (WHO, 2004) reported that almost all human cases of this disease are transmitted via dog bites. Outbreak of these cases have been on the higher side for the past 20 years in Africa and Asia (Atuman, 2011), and the rapid growth in domestic dog populations is termed to be responsible (WHO, 1984). The importance of data on dog populations in Nigeria coupled with these reasons informed our study on dog ecology for this study area.

Different dog ecology studies have been used ranging from estimation of dog density by distance sampling, capture-mark-release-and-recapture method following a mass vaccination, use of questionnaires distributed to households and use of roaming dog population estimates (FAO, 2014).The study explores dog populations and dog-to-human ratio on ABU campuses and Bomo village as rural setting using questionnaires, with the objectives of determining dog population, dog-to-human ratio, dog population structure, reasons for keeping dogs and anti-rabies vaccination (ARV) status of dogs in both study areas.

Materials and Methods

Study area

The study included rural and urban areas, with the rural consisting of Bomo village while the urban areas included ABU main campus and staff quarters which are located within Zaria metropolis, and separated from Bomo village by a 500 meters road on the north eastern axis.

The ABU main campus and Bomo village are located in Samaru, Sabon Gari Local Government Area of Kaduna State. Sabon Gari is positioned at $11^{o}3'$N and $7^{o}2'$E. It was created out of Soba Local Government area by the military government of Nigeria on the 27th August, 1991. It is located in the northern fringes of the northern guinea savannah vegetation zone on a plateau of about an area of 60m above sea level. It has a land mass area of 600km^2 and shares boundaries with Zaria, Soba, Giwa, Makarfi and Ikara Local Government areas. Two major seasons are experienced annually in the area: the dry and wet seasons. The average annual rainfall is 100mm, with peak temperature of 44^{o}C in April and the lowest temperature of 20^{o}C in October. The location is made up of Christians and Muslims from different ethnic backgrounds including Hausa/Fulani, Yoruba, Igbo, Tiv, Baju, Igala, Idoma, Ebira, Nupe, Ijaw and Okun. The 2006 Nigerian population census estimated a human population of 291,358 in Sabon Gari (NPC, 2006).

Ethical approval

This study received an ethical approval from the research and ethical review committee of the

Department of Veterinary Public Health and Preventive Medicine, ABU Zaria.

Data collection

Data collection was carried out using questionnaires (Oboegbulem & Nwakonobi, 1989). Of the six hundred questionnaires distributed, 510 were returned from 210 households in the urban areas (ABU campus and quarters), and 300 from the rural area (Bomo village) from December, 2013 – March, 2014. The following information was solicited for by the questionnaire: the number of people living per household, enclosure of household, garbage handling, whether they keep dogs or not, reasons why, whether their dogs eat at their homes or not, incident of dog bite, dogs' shelter, feeding/source of food, persons who play with dogs, vaccination status of the dog(s) and dog's restriction.

Data analysis

Data obtained were entered manually into the computer and analyzed using Statistical Package for Social Science (SPSS version 21). Descriptive statistical procedures were used. Significant associations were established by Chi-square tests ($p < 0.05$).

Results

Data analysis from the urban area (ABU Zaria) showed that 79 (37.6%) out of 210 households surveyed owned dogs, a total of 144 dogs were recorded, yielding a dog to household ratio of 68.65:100 (Table 1). Results of data analysis from rural areas (Bomo) sampled, revealed that 22 (7.3%) out of the 300 households owned dogs, yielding dog to household ratio of 13.7: 100 (Table 1). The dog-to-human ratio for urban and rural areas was 1:7.6 and 1:219.5 or 131.6 per 1000 persons and 4.6:1000 respectively (Table 2).

The majority of the dogs sampled in rural (65.9%) and urban (68.8%) areas were adult dogs above one year old. Furthermore, 16.7% and 29.3% of dogs in urban and rural areas, respectively, were less than 6 month old. Only 14.6% and 4.9% of dogs in both urban and rural areas, respectively, were above 6 months but less than one year old. Breed representation showed that 64% and 100% of dogs enrolled for both urban and rural settings, respectively, were mongrels. Neither exotic nor mixed breeds were recorded in the rural areas, but 11.4% and 24.1% exotic and mixed breeds, respectively, were recorded in the urban areas (Table 3).

The variation in vaccination against rabies was not statistically significant ($P>0.05$, $\chi 2$) for both urban and rural areas (Table 4). None of the rural dwellers kept dogs as pets while 11.4% of owned dogs in urban area were kept as pets. The majority of the owned dogs in urban (82.3%) and rural (95.5%) areas were kept as security/guard dogs, and only 1.2% and 4.5% of dogs in the urban and rural areas, respectively, were kept for hunting purposes (Table 3). Only 24.1% of dogs enrolled in the urban areas were always confined, but none was completely confined or restricted in rural areas. (Table 3). Chi-square analysis of the difference between

Table 1: Dog population distribution in ABU (urban) and Bomo village (rural) of Kaduna state, Nigeria

Area	H/holds Surveyed	Total dogs	Dogs/100 h/holds	H/hold with/without dogs				Total H/holds with dogs	Total H/holds without dogs
				0	1	2	>2		
Urban (ABU)	210	144	68.5	131	44	15	20	79	131
Rural (Bomo)	300	41	7.3	278	10	8	4	22	278
Urban & rural	510	185	37.9	409	54	23	24	101	409

Table 2: Dog population estimate and dog to man ratio in ABU (urban) and Bomo village (rural) of Kaduna state, Nigeria

Parameters	Urban	Rural
No. of households sampled	210	300
Average no. of persons per household	5.2	30
Total no. of dogs	144	41
Dogs/1000 persons	131.9	4.6
Dog to man ratio	1:7.6	1:219.5
Total dog population	144	41

Table 3: Population structure of dogs enrolled in ABU (urban) and Bomo village (rural) of Kaduna state, Nigeria

Parameters	Urban	Rural	Total
Number of dogs	144	41	185
Sex			
Male	107 (74.3%)	35 (85.4%)	142
Female	37 (25.7%)	6 (14.6%)	43
Male: female ratio	2.9:1	5.8:1	
Age			
Puppies	24 (16.7%)	12 (29.3%)	36
Juvenile	21 (14.6%)	2 (4.9%)	23
Adult	99 (68.8%)	27 (65.9%)	126
Breed			
Local (Mongrel)	91 (64.6%)	41 (100%)	132
Exotic	16 (11.4%)	0 (0%)	16
Cross (mixed)	34 (24.1%)	0 (0%)	34
Confinement			
Never	27 (34.2%)	15 (68.2%)	42
Partially (day/night)	33 (41.7%)	7 (31.8%)	40
Always	19 (24.1%)	0	19
Function of dogs			
Pet	9 (11.4%)	0	9
Guard	65 (82.3%)	21 (95.5%)	86
Hunting	1 (1.2%)	1 (4.5%)	2
Pet and guarding	4 (5.1%)	0	4
Proportion of dogs validly vaccinated against rabies	58 (41%)	2 (9.1%)	60 (50.1%)

Table 4: Chi-square analysis of population distribution and dog vaccination status in ABU (urban) versus Bomo village (rural) areas of Kaduna state, Nigeria

	Urban	Rural	Total	χ^2
Household with dogs	79	22	101	71.34
Household without dogs	131	278	409	
Duly vaccinated dogs	58	2	60	1.9375
Unvaccinated dogs	86	39	125	

urban/rural and the number of household with dogs was significant ($p < 0.05$) (Table 4). Similarly, these findings also established association between the number of dogs in a household (0, 1, 2, 3, 4, 5, 6, ≥7) and locality ($p < 0.05$) (Table 4).

Discussion

The dog population census in ABU and Bomo village, Kaduna state was carried out using questionnaire survey, where 144 and 41 dogs were recorded in urban and rural areas, respectively. These finding are similar to the earliest studies on dog ecology in Nigeria carried out by Oboegbulem & Nwakonobi (1989) where the number of dogs owned by urban households outnumbered that of the rural households. The present study has reported a dog-to-human ratio of 1: 7.6 and 1: 219 for urban (ABU) and rural (Bomo village) households respectively. Few studies on rural household's dog ecology are available to compare with the present finding. However, the dog-to-human ratio in the urban area reported in this study may be relatively higher compared to ratios obtained in other urban areas in Nigeria including 1: 39 in Ilorin (Aiyedun & Olugasa, 2012). Again, the ABU urban dog-to-human ratio was far less than the 1:4.1 dog-to-human ratio obtained in urban households of Bauchi (Atuman *et al.,* 2014); 1:4 in Benue state (Omude *et al.,* 2010); 1:4.5 in Zimbabwe (Brooks, 1990); 1:5 in Madagascar (Ratsitorahina *et al.,* 2009); and 1:4.3 in Mexico (Flores-Ibarra & Estrella-Valenzuela, 2004). It is interesting to note that the ABU dog-to-human ratio is completely similar to that of 1:7.8 in Abia state (Otolorin *et al.,* 2014). Although, according to Franti

et al. (1974) increased dog population correlate with financial earnings and position of dog owners. However, in our opinion increased criminal or security challenges faced by urban dwellers may be the major reasons for the high number of dogs and high dog-to-human ratio observed in this study area.

The presence of more older and male dogs reported in this study may create fear and concern about the outbreak of important zoonotic diseases of companion animals such as rabies, since there was little restriction to dog movement and older/male dogs wander in search of partners for breeding.

WHO (1980), explains that the total number of males per 100 females is called sex ratio, and it is recommended to be 1:1 at birth. However, the present study demonstrated a male to female ratio to be 3.1:1 in the urban and 5.8:1 in the rural areas., this is comparatively higher than the male to female ratio of 1.52 recorded in Antananarivo Madagascar (Ratsitorahina *et al.,* 2009). FAO (2014) suggested that control of reproduction in dogs is meant to avoid the presence of undesired group of dogs. Dog owners within this location preferred male dogs to female dogs, since most of these dogs are kept as house guards and not for breeding purpose as indicated by our findings. Keeping only male dogs without expecting future pups reduces health and feeding cost burden for dog owners.

The study carried out in Madagascar by Ratsitorahina *et al.* (2009) demonstrated that mature adult dogs outnumbered juveniles and puppies in all the areas that were surveyed. Although, determination of the ages of all the dogs enrolled in this study was bias as aging was done by depending solely on the history of birth provided by the dog owners. Notwithstanding, data analysis showed that 68.8% and 65.9% of dogs in urban and rural areas respectively, were adults. This may not be unconnected to the time of the year as dogs are seasonal breeders and data collection here coincided with the mating period (December – March) in Zaria and environs. A representation of more active adult population of dogs in this study is also alarming, as this may also be a risk factor for the spread of rabies, this is because a rabid dog has higher possibility of contact with other dogs because it wanders wildly and puppies are protected by maternal immunity.

Up to 59.5% of dog owners restricted their dog's movement and provide feeding in urban areas. It is however, alarming that a good number of dogs (68.2%) were never confined in rural areas, such dogs scavenge around neighbouring houses for food.

The presence of a relatively large number of free roaming or stray dogs recorded in this study in both rural and urban areas may be of great concern and worry. This may results into the presence of dog packs and wide spread transmission of zoonotic diseases of companion animals such as rabies (FAO, 2014). Similarly, the presence of such a huge number of dogs may further result in environmental pollution, social nuisance, dog bites and increased exposure of humans to rabies (Oboegbulem & Nwakonobi, 1989).

In conclusion, this study showed that there were more dogs per household as well as per person in the urban area than the rural area. There was significant difference between the mean number of dogs/household in urban areas and rural areas. There were more male dogs than female dogs in urban than rural areas and both study areas were populated with more adult dogs than puppies or juveniles. Dogs are allowed to wander or roam in both urban and rural settings. Up to 41% of the dogs in the urban areas were vaccinated against rabies while only 9.1% of dogs in rural area were vaccinated against rabies. This is of public health significance as the vaccination level was below the World Health Organization recommended standard of 70% -80%. Also, the degree of straying was more in the rural area than the urban area as more dogs were placed under restricted movement in the urban areas.

It is recommended that the questionnaire survey in this study does require complimentary studies in new areas, in more states. Public education is needed especially in the rural areas, for informing the residents on the importance of vaccination of dogs against rabies. Enforcement of the already existing laws on dog movement control within ABU campus and Bomo village by ensuring that all dog owners keep to the tenets of leash law, and restrict free movement of dogs.

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