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DEMOGRAPHIC FACTORS INFLUENCING THE RABIES ANTIBODY PREVALENCE OF DOGS IN FEDERAL CAPITAL TERRITORY, NIGERIA

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ABSTRACT

Canine rabies is enzootic in Nigeria occurring in all parts of the country. Rabies has been reported in Niger state neighbouring the Federal Capital Territory (FCT) and the movement of rabid dogs between the neighbour states is possible. Hence, a study to determine the immune status of dogs in Abuja to rabies was necessary. A cross sectional study was carried out to assess the rabies antibody titre of owned dogs and the rabies knowledge, attitude and practices of the dog owners. Serum samples from 276 dogs were collected and a structured questionnaire administered to each dog owner using a personal interview method. Associations between the demographic variables, protection titres and knowledge attitude and practice (KAP) were assessed using χ^2 analysis. Sera samples were analysed to measure for rabies antibodies using an indirect enzyme linked immunosorbent assay. Out of the 276 dogs sampled, 229 (83 %) had a certified antirabies vaccination record. All vaccinated dogs had antibody titre against rabies greater than 0.6 EU.ml^{-1}. The dog owners had a mean knowledge score of 63.54 ± 23.82 %, mean attitude score of 81.45 ± 20.37 % and the mean practice score was 91.3 ± 21.39 %. There was a significant association between the vaccination status of the dogs and categorized knowledge score ($P < 0.05$), attitude score ($P < 0.05$) and practice score ($P < 0.05$). A large proportion of the dogs (47.4 %) owned by residents of satellite towns were not vaccinated against rabies. Hence mass vaccination of dogs in these suburban settlements is strongly recommended

Key words: antibody; dog owners; rabies

INTRODUCTION

Rabies is a zoonotic disease of high public health importance which has been in existence since 3000 BC [16, 21]. Dogs are universally accepted to be the most important source of the transmission of rabies to humans [8, 17, 20]. There have been few rabies cases where recovery has occurred, and they were predominantly caused by the bat variant rabies viruses [4, 5]. Most human rabies deaths

occur in the developing countries and although effective and economical control measures are available, their application in developing countries have been hampered by a range of economic, social and political factors [14, 21]. It is widely recognized that the number of deaths officially reported in most developing countries greatly underestimates the true incidence of the disease, with several factors contributing to this widespread under reporting [21]. The prevalence rate of rabies in Nigeria is between 15—20 % and the true picture cannot be easily determined because of under reporting [10]. The preventive vaccination against rabies virus is a highly effective method for preventing rabies in humans and other animals. In Nigeria where dog bites continue to be the main mode of transmission of the disease to humans, it remains a serious public health hazard [1, 12]. Documented reports have been published citing cases of rabies in a few vaccinated dogs [1, 13]. The World Health Organization stipulates a minimum of 0.5 IU.ml^{-1} serum levels of rabies antibody titre for the confirmation of immunity against rabies [21]. The serological evidence of rabies virus neutralizing antibodies in the serum of vaccinated and unvaccinated rabies occupational risk groups have been reported in Niger state bordering Federal Capital Territory (FCT) [9]. Rabies virus neutralizing antibodies can be present in roaming or hunting dogs that have been exposed to rabies virus (carriers) but the rabies virus antibodies are usually at suboptimal levels [15]. A knowledge attitude and practice (KAP) study is a social research method (survey) targeted at measuring changes in human knowledge, attitudes and practices in response to a specific project activity; usually involving education or outreach [6]. It is a representative study conducted on a specific population to collect information on what is known, believed and done in relation to any subject of interest [18]. Understanding the levels of knowledge, attitude and practice will enable a more efficient process of awareness creation as it will allow the program to be tailored more appropriately to the needs of the community [11]. Rabies knowledge, attitude and practice studies have been conducted in different parts of Nigeria on dog owners and dog meat processors with varied KAP scores [3, 7]. In the KAP study conducted on Abuja Municipal Area Council residents, 82 % of the respondents had a satisfactory knowledge of rabies, 165 (74 %) had a positive attitude and 91 (75 %) of dog owners had a satisfactory practice [7]. Rabies has remained endemic in Nigeria and has been reported in slaughtered dogs in Abuja Municipal Area of the Federal Capital Territory [7].

The aim of this study is to evaluate some demographic factors influencing the antibody response of dogs against rabies, the prevalence of rabies antibodies in owned dogs and determine the level of compliance of dog owners resident in the Federal Capital Territory of Nigeria to preventive canine rabies vaccination.

MATERIALS AND METHODS

Study area

This study was carried out in three phases and two major satellite towns (Kubwa and Gwagwalada) in the Fed-

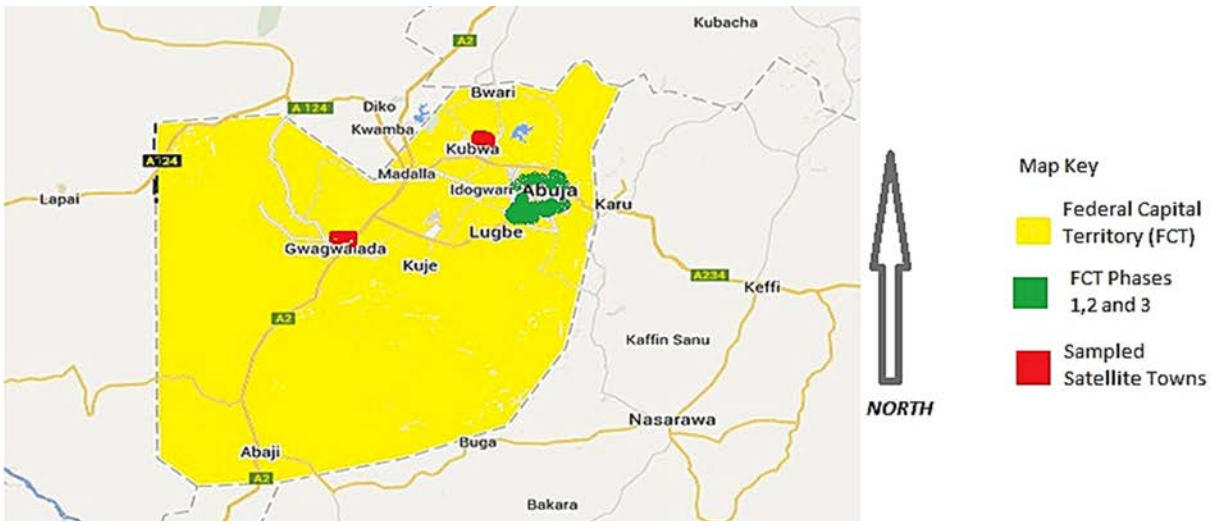

Fig. 1. Modified Google map of the Federal Capital Territory of Nigeria [19]

eral Capital Territory (FCT) of Nigeria. Abuja is the federal capital territory of Nigeria; it is a planned city with districts organized into three major phases (i.e. phases 1, 2 and 3). It is bordered by Kaduna state in the North, Nasarawa state in the South-East, Kogi state in the South-West and Niger state in the West. Geographically it lies between latitude 9°4'0" North and longitude 7°29'0" East with an area of 713 km^2 and had a population of 776,298 at the 2006 census. It has a few state-owned veterinary hospitals/clinics including the University of Abuja Veterinary Teaching Hospital and a host of private veterinary clinics dispersed across major commercial districts. English is the official language in Abuja and well-spoken by most residents. Abuja was formerly inhabited by the Gbagyi or Gbari (commonly known as Gwari) tribe who are predominantly farmers now resettled in bordering states, but a few pockets of locals are still found in areas such as Gwagwalada [19].

Sample size

A major limitation in this study was the fact that most dog owners in the Federal Capital Territory of Nigeria reside in estates with strict security setups therefore could not be easily accessed, this limited the sample size obtained within the specified period (December 2014 to February 2015). Two hundred and seventy-six samples were collected for this study due to accessibility and time (December 2014 to February 2015) constraints.

Survey methods

A total of 276 structured questionnaires were administered to certified dog owners following a pre-test survey conducted on 20 dog owners within the study area. A structured questionnaire was designed and pre-tested (employing personal interviews) on 20 dog owners within the study area. The pre-test questionnaires were then analysed and restructured for better effectiveness. A total of 276 restructured questionnaires were then administered to the dog owners (one questionnaire per dog) in 8 major cadastral zones within the 3 phases of Abuja metropolis (Wuse 2 and Asokoro in phase 1, Jabi in phase 2, Gwarinpa and Life Camp in phase 3) and two satellite towns (Gwagwalada and Kubwa) with the assistance of 8 private veterinary clinics located within these zones. The questionnaire administered comprised of the demographic information of the dog owners contained in section A, zoographic information and vaccination history of the owned dog was obtained in section B, whilst the knowledge, attitude and practice of the dog owners as it pertained to rabies was contained in sections C, D and E respectively which included questions on the mode of transmission, clinical symptoms and preventive measures.

The personal interviews were conducted by the researcher explaining the questionnaire to the dog owners and the responses were recorded. Responses for the Knowledge section was coded, "Yes", "No", and "Don't know"; the Attitude section was coded, "Agree", "Disagree", and "Indifferent"; the Practice section was coded, "Yes", or "No". A marking scheme of expected correct answers was prepared and used to grade the responses. "Don't know", "Indifferent", or undecided responses were considered wrong answers. Each correct response earned one point, whilst every wrong response was graded zero.

Sample collection

A total of 276 canine serum samples were collected from Wuse 2 and Asokoro in phase 1, Jabi in phase 2, Gwarinpa and Life Camp in phase 3. Canine serum samples were also collected from two satellite towns of Gwagwalada and Kubwa based on availability of dogs and the cooperation of the owners.

The dogs were restrained properly, the site for blood collection (cephalic vein) was well swabbed using a mild disinfectant and with the aid of sterile needles and syringes (22-gauge 5 ml syringes), 3—5 ml of blood was collected from each dog, into plain labelled sample bottles without anticoagulant and allowed to clot by placing them in a rack for 4—5 hours. The sera were then gently decanted into screw cap serum bottles and stored in the fridge (+4 °C) until they were analysed in the laboratory.

Laboratory analysis

The sera were stored at +4 °C (cumulatively for about 2 months, sera that were stored for more than 7 days were stored in the freezer compartment for stability) until tests were conducted using an ELISA technique (SERELISA® Rabies Ab Mono Indirect Kit). The optical density readings of the test wells were read using a monochromatic plate reader at 450 nm. The rabies antibody titre of sampled dogs was then deduced.

Statistical analysis

All data were collated and sorted out using Microsoft

EXCEL spreadsheet; analyses of the data were carried out using a Statistical Package for Social Sciences software, SPSS (version 17, SPSS Inc. Chicago IL USA). A regression analysis of the World Health Organisation standard serum optical readings was used to derive the mathematical model which was subsequently used to derive the equivalent unit per millilitre ($EU.ml^{-1}$) of antibody titre in each serum sample. A calculated titre greater than 0.6 $EU.ml^{-1}$ was considered protective, whilst a calculated titre of less than 0.6 $EU.ml^{-1}$ was considered nonprotective based on the kit's recommended standard. The association between the dependent variable and independent variables were assessed using a Chi-Square (χ^2) analysis at 95 % confidence interval; a P-value less than 0.05 were considered significant. A scatter plot was utilized to observe the relationship between the time lapse from vaccination to sample collection and the antibody titre of the sample sera. The mean knowledge, attitude and practice scores were computed, respondents with knowledge, attitude and practice scores equal or greater than the mean scores were considered good knowledge, attitude and practice, whilst those who had scores below the mean were categorized as having poor knowledge, attitude and practice [3]. The associations between demographic variables and categorized scores were assessed using χ^2 test of association at 95 % confidence intervals. P values less than 0.05 were considered significant in the χ^2 analysis. Binary regression analyses were carried out to assess the relationships between non-categorized scores.

RESULTS

The relevant demographic characteristics of dog owners and zoographic characteristics of dogs sampled in FCT, Nigeria, are presented in Tables 1 and 2.

Vaccination coverage of the dogs

A total of 200 (72.5 %) dogs were sampled in the City centre, i. e. phases 1, 2, and 3. The sum of 118 samples were collected in phase 1 out of which 109 (92.37 %) were vaccinated; in phase 2, 33 samples were collected out of which 32 (96.97 %) of the dogs had certificates of antirabies vaccination. The sum of 49 samples were collected in phase 3 out of which 48 (97.96 %) dogs had certificates of antirabies vaccination whilst out of the 76 dogs in the satellite towns, 40 (52.63 %) were certified vaccinated. A total of 276 dogs were sampled, 228 (82.6 %) were of exotic breed origin and 48 (17.4 %) were indigenous. Notably, 218 (95.6 %) of the exotic breed of dogs were vaccinated whilst only 11 (22.9 %) of the indigenous breed of dogs were vaccinated.

Rabies antibody profile (prevalence) of owned dogs

a) Prevalence of rabies antibodies in the dogs

A total of 276 serum samples were collected, processed and analysed during this study. Out of the 276 dogs, all vaccinated dogs i. e. 239 (86.6 %) had rabies antibody titre > 0.6 $EU.ml^{-1}$ whilst all unvaccinated dogs, i. e. 37 (13.4 %) had less than 0.6 $EU.ml^{-1}$. There was a marked decline in rabies antibody titre with increase in time post vaccination

Table 1. Demographic characteristics of dog owners in FCT, Nigeria (December 2014 to February 2015)

Variables		Total number of respondents N = 276	Percentages [%]
Area of residence	City Centre (phases 1, 2, 3)	200	72.5
	Satellite towns/ Suburbs	76	27.5
Gender	Male	243	88.0
	Female	33	12.0
Occupation	Corporate institution personnel	153	55.4
	Traders	123	44.6
Education level	Tertiary	234	84.8
	Secondary/Primary	42	15.2

Table 2. Zoographic characteristics of dogs sampled in FCT, Nigeria (December 2014 to February 2015)

Variables	Response	Total number of respondents N = 276	Percentages [%]
Dog breed	Exotic breed	228	82.6
	Local breed	48	17.4
Dog's age	< 1year	17	6.2
	> 1year	259	93.8
Sex of dog	Male	158	57.2
	Female	118	42.8
Source of dog	Imported	53	19.2
	Breeder	223	80.8
Purpose for dog	Pet	86	31.2
	Breeding	25	9.1
	Security	165	59.8
Vaccination status	Certified Vaccinated	229	83.0
	Not-vaccinated	37	13.4
	Vaccinated but not certified	10	3.6

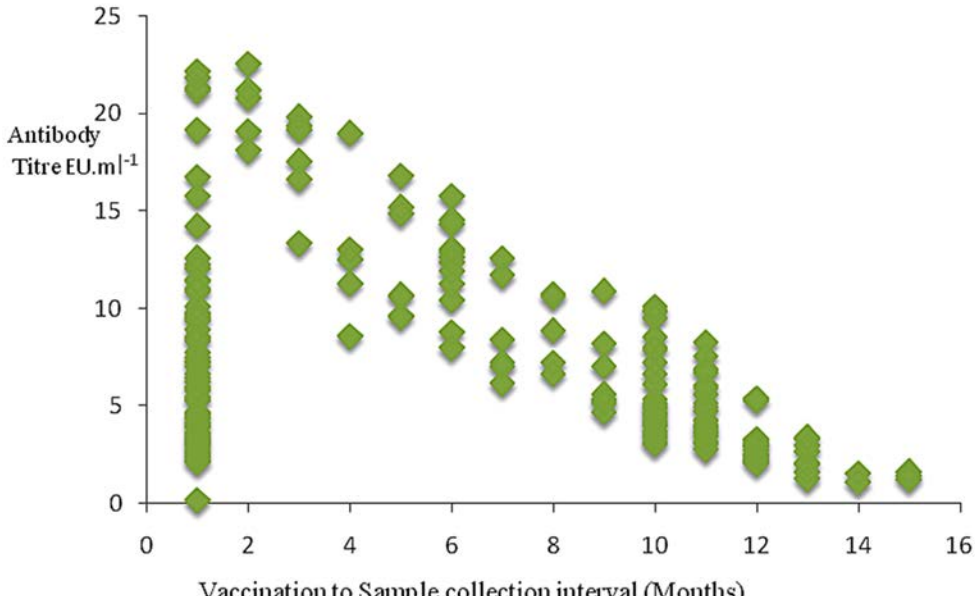

Fig. 2. Association between vaccination to sample collection interval and antibody titre of the dogs in FCT, Nigeria (December 2014 to February 2015)

as shown in Figure 2. For clarity, 0.5—1.4 months was categorized as 1 month, 1.5—2.4 months as 2 months, etc.

b) Association between demographic characteristics of dog owners and the rabies antibody titre of the dogs

The sum of 200 dogs was sampled in the City centre (phases 1, 2 and 3). Notably, all the dogs in FCT phases 1and 2 had their rabies antibody titre > 0.6 EU.ml^{-1}, only 1 (2 %) out of the 49 dogs in FCT phase 3 had rabies antibody titre less than 0.6 EU.ml^{-1}. However, 36 (47.4 %) out of the 76 dogs in the satellite towns/suburbs had rabies antibody titre less than 0.6 EU.ml^{-1}. When the gender of the dog owners was considered as a possible factor that can affect the vaccination of dogs against rabies and consequently rabies antibody titre, 36 (14.8 %) of the 243 dogs owned by male dog owners had rabies antibody titre less than 0.6 EU.ml^{-1} whilst only 1 (3 %) of 33 dogs owned by female dog owners had rabies antibody titre less than 0.6 EU.ml^{-1}. Following the consideration of the occupation of dog owners as a possible factor affecting the vaccination of dogs against rabies and consequently rabies antibody titre, it was observed that all 153 (100 %) of the dogs owned by civil servants, private sector workers and students (corporate institution personnel) had rabies antibody titre > 0.6 EU.ml^{-1} whilst 37 (30.3 %) of 123 dogs owned by business inclined persons (traders) had rabies antibody titre less than 0.6 EU.ml^{-1}. It was also observed that dog owners having 1—5 dogs were 184 (66.7 %) out of the 276 dogs but had only 5 (2.7 %) dogs with rabies antibody titre lesser than 0.6 EU.ml^{-1} in contrast to dog owners that owned more than 5 dogs with their frequency of occurrence as 92 (33.3 %) out of the 276 dogs but had 32 (34.8 %) of their dogs having rabies antibody titre less than 0.6 EU.ml^{-1}. Notably also out of the 234 dogs owned by tertiary school certificate holders, only 1 (0.4 %) had rabies antibody titre less than 0.6 EU.ml^{-1} whilst 36 (85.7 %) of the dogs owned by secondary and primary school leavers had rabies antibody titre less than 0.6 EU.ml^{-1}.

Taking χ^2 as Chi square, df as the degree of freedom and P as the P-value, significant associations were observed between rabies antibody titre and the area of residence ($\chi^2 = 99.76$; df = 1; $P < 0.05$), occupation ($\chi^2 = 67.06$; df = 1; $P < 0.05$), number of dogs owned ($\chi^2 = 52.71$; df = 1; $P < 0.05$), the education of dog owners ($\chi^2 = 170.15$; df = 1; $P < 0.05$) and the gender of dog owners ($\chi^2 = 4.67$; df = 1;

Table 3. Association between demographic characteristics of dog owners and the rabies antibody titre of dogs in FCT, Nigeria (December 2014 to February 2015)

Categorical predictor variable	Protective titre frequency	Non-protective titre frequency	Likelihood ratio (LR)	Odds ratio	Confidence interval for OR (95 %)
Area of residence					
City centre (phases 1, 2, 3)	199 (99.5 %)	1 (0.5 %)	$\chi^2 = 99.76$ df = 1	0.006	0.001—0.042
Satellite towns/ Suburbs	40 (52.6 %)	36 (47.4 %)	P < 0.001	1	DV
Gender					
Male	207 (85.2 %)	36 (14.8 %)	$\chi^2 = 4.67$ df = 1	5.565	0.737—42.019
Female	32 (97 %)	1 (3 %)	P = 0.031	1	DV
Occupation					
Corporate institution personnel	153 (100)	0 (0)	$\chi^2 = 67.06$ df = 1	0.000	0.000—IND
Traders	86 (69.7)	37 (30.1)	P < 0.001	1	DV
Level of education Level of education					
Tertiary	233 (99.6)	1 (0.4)	$\chi^2 = 170.148$ df = 1	0.001	0.000—0.006
Primary/secondary	6 (14.3)	36 (85.7)	P < 0.001	1	DV

df — degree of freedom; IND — indeterminate (blank output); DV — dummy variable (cells are redundant)

P < 0.05) (Table 3). The Odds ratios showed that dog owners residing in the satellite towns, men, traders and those with only secondary or primary education had more dogs with non-protective rabies antibody titres (Table 3).

c) Association between the zoographic characteristics of sampled dogs in FCT, Nigeria and measured rabies antibody titre

Out of the 276 dogs, all 228 (100 %) of the exotic breed of dogs had rabies antibody titre > 0.6 EU.ml^{-1} whilst 37 (77.1 %) of the 48 indigenous breeds of dogs had less than 0.6 EU.ml^{-1} levels of rabies antibody titre. Age evaluation reflected that all 17(100 %) dogs lesser than 1year of age had > 0.6 EU.ml^{-1} rabies antibody titre whilst 37(14.3 %) of the 259 dogs that were > 1year of age had rabies antibody titre less than 0.6 EU.ml^{-1}. Following the evaluation of sex of the dogs as a possible factor affecting vaccination against rabies and consequently rabies antibody titre, 12 (7.6 %) of the 158 males and 25 (21.2 %) of the 118 female dogs had less than 0.6 EU.ml^{-1} rabies antibody titre. All 53 (100 %) of the dogs acquired by importation had rabies antibody titre > 0.6 EU.ml^{-1} whilst 37 (16.6 %) of the 223 dogs acquired from breeders (commercial breeders and friends whose dogs whelped) had less than 0.6 EU.ml^{-1} rabies antibody titre.

Significant associations were observed between breed ($\chi^2 = 165.83$; df = 1; P < 0.05), age ($\chi^2 = 5.06$; df = 1; P < 0.05), sex ($\chi^2 = 10.70$; df = 1; P < 0.05), source ($\chi^2 = 17.09$; df = 1; P < 0.05) and the rabies antibody prevalence of the dogs (Table 4). Also, the odds ratios showed that dogs of indigenous origin (local), acquired from friends and those raised for security purposes had more non-protective rabies antibody titres (Table 4).

Knowledge attitude and practices (KAP) of dog owners towards rabies

a) Knowledge of rabies

The mean knowledge score was 63.54 ± 23.82 % in

Table 4. Association between zoographic characteristics of dogs in FCT, Nigeria and their measured rabies antibody titre (December 2014 to February 2015)

Categorical predictor variable	Protective titre frequency	Non-protective titre frequency	Likelihood ratio (LR)	Odds ratio	Confidence interval for OR (95 %)
Breed					
Exotic	228 (100 %)	0 (0)	$\chi^2 = 165.83$ df = 1	0.000	0.000—IND
Local	11 (22.9 %)	37 (77.1 %)	P < 0.001	1	DV
Age (years)					
< 1year	17 (100 %)	0 (0)	$\chi^2 = 5.064$ df = 1	0.000	0.000—IND
>1year	222 (85.7 %)	37 (14.3 %)	P = 0.024	1	DV
Sex					
Male	146 (92.4 %)	12 (7.6 %)	$\chi^2 = 10.7$ df = 1	0.306	0.146–0.638
Female	93 (78.8 %)	25 (21.2 %)	P = 0.001	1	DV
Source					
Imported	53 (100 %)	0 (0)	$\chi^2 = 17.09$ df = 1	0.000	0.000—IND
Breeder (Commercial or friends with pups)	186 (83.4 %)	37 (16.6 %)	P < 0.001	1	DV
Purpose					
Pet	85 (98.8 %)	1 (1.2 %)	$\chi^2 = 33.49$	0.042	0.006—0.313
Breeding	25 (100 %)	0 (0)	df = 2	0.000	0.000—IND
Security	129 (78.2 %)	36 (21.8 %)	P < 0.001	1	DV

df — degree of freedom; IND — indeterminate (blank output); DV — dummy variable (cells are redundant); P — P-value

a questionnaire of 15 items, 76 out of the 276 respondents (27.5 %) knew rabies is not curable; 146 (52.9 %) agreed rabies can affect humans and 221 (80.1 %) knew death to be the most likely the end result of rabies. One hundred and nine respondents (39.5 %) knew that rabies could be found in the saliva; all the respondents agreed that all dogs can be infected with and subsequently transmit rabies whilst 144 (52.2 %) knew that an unprovoked bite by a dog is a poten-

Table 5. Knowledge of dog owners in FCT, Nigeria, about rabies (December 2014 to February 2015)

Characteristics	Response	Total number of respondents N = 276	Percentages (%)
Rabies is curable	Yes	104	37.7
	No	76	27.5
	No idea	96	34.8
Rabies cannot affect humans	Yes	34	12.3
	No	146	52.9
	No idea	96	34.8
Death is rabies result	Yes	221	80.1
	No	0	.0
	No idea	55	19.9
Rabies is found in blood	Yes	109	39.5
	No	70	25.4
	No idea	97	35.1
All dogs can be infected/transmit rabies virus	Yes	276	100.0
	No	0	.0
	No idea	0	.0
Dogs are the major source of rabies	Yes	221	80.1
	No	0	.0
	No idea	55	19.9
Unprovoked bite is a rabies potential source	Yes	144	52.2
	No	69	25.0
	No idea	63	22.8
Rabies can never be transmitted from dog to humans	Yes	0	.0
	No	201	72.8
	No idea	75	27.2
Bite from infected animal cannot affect other animals	Yes	0	.0
	No	138	50.0
	No idea	138	50.0
Friendly dog suddenly turned aggressive may be rabid	Yes	213	77.2
	No	0	.0
	No idea	63	22.8
Excessive foamy salivation and biting tendency is not rabies sign	Yes	103	37.3
	No	35	12.7
	No idea	138	50.0
Contact with sick dog can endanger your health	Yes	276	100.0
	No	0	.0
	No idea	0	.0
Vaccination of dogs is the most effective rabies prevention method	Yes	213	77.2
	No	0	.0
	No idea	63	22.8
Dog registration and licensing help in controlling rabies	Yes	213	77.2
	No	0	.0
	No idea	63	22.8
Roaming increases the likelihood of dog rabies	Yes	221	80.1
	No	0	.0
	No idea	55	19.9

tial source of rabies. Two hundred and one of the 276 respondents (72.8 %) believe that rabies can be transmitted from dog to humans; 138 (50 %) knew that other animals can equally be infected by a bite from an infected animal.

Out of the 276 respondents, 213 (77.2 %) agreed that a friendly dog that suddenly turned aggressive may be rabid, whilst only 35 (12.7 %) knew that excessive foamy salivation and biting tendency were signs of rabies. All the respondents knew that contact with a sick dog can endanger their health; 213 (77.2 %) agreed that dog registration and licensing can help in controlling rabies and 221 (80.1 %) knew that allowing dogs to roam free increases the likelihood of dog rabies (Table 5).

b) Association between demographic variables and the categorized knowledge scores of dog owners in FCT, Nigeria

There was a significant association between categorized knowledge scores and the area of residence of dog owners ($\chi^2 = 25.59$; df = 1; $P < 0.05$), gender ($\chi^2 = 0.892$; df = 1; $P < 0.05$), occupation of dog owners ($\chi^2 = 11.66$; df = 1; $P < 0.05$) and owner's education level ($\chi^2 = 54.78$; df = 1; $P < 0.05$) (Table 6). The Odd ratios reflected the fact that dog owners in the satellite towns or suburban areas, males, traders, having not more than secondary or primary school leaving certificates had more respondents with poor knowledge about rabies.

c) Attitudes towards rabies

The mean attitude score was 81.45 ± 20.27 %. Two hundred and sixty nine out of the 276 respondents (97.5 %) agreed that bites by suspected animals should be reported immediately to the doctor and 208 (75.4 %) agreed rabies is a disease of great importance to humans. Out of the 276 respondents interviewed, 261 (94.6 %) agreed all dogs should be vaccinated against rabies; 227 (82.2 %) believe vaccinating dogs yearly is necessary to prevent rabies. Two hundred and thirty-five of the interviewed dog owners (85.1 %) agreed it is wrong to allow dogs to roam; 194 (70.3 %) agreed children must not play with stray animals and 178 (64.5 %) said washing bite wounds with soap and water before seeking medical help is necessary (Table 7).

d) Association of demographic variables to the categorized attitude scores of dog owners towards rabies

There was a significant association between catego-

Table 6. Association between demographic variables of dog owners with their categorized knowledge scores on rabies in FCT, Nigeria (December 2014 to February 2015)

Categorical predictor variable	Good knowledge	Poor knowledge	Likelihood ratio (LR)	Odds ratio	Confidence interval for OR (95 %)
Area of residence					
City centre (phases 1, 2, 3)	143 (71.5 %)	57 (28.5 %)	$\chi^2 = 25.59$ df = 1	0.246	0.141—0.429
Satellite towns/ Suburbs	29 (38.2 %)	47 (61.8 %)	P < 0.001	1	DV
Gender					
Male	149 (61.3 %)	94 (38.7 %)	$\chi^2 = 0.89$ df = 1	1.451	0.661—3.184
Female	23 (69.7 %)	10 (30.3 %)	P = 0.345	1	DV
Occupation					
Corporate institution personnel	109 (71.2 %)	44 (28.8 %)	$\chi^2 = 11.66$ df = 1	0.424	0.258—0.697
Traders	63 (51.2 %)	60 (48.8 %)	P < 0.001	1	DV
Level of education					
Tertiary	167 (71.4 %)	67 (28.6 %)	$\chi^2 = 54.78$ df = 1	0.054	0.020–0.14
Primary/secondary	5 (11.9 %)	37 (88.1 %)	P < 0.001	1	DV

df — degree of freedom; IND — indeterminate (blank output); DV — dummy variable (cells are redundant); P — P-value

Table 7. Attitude of dog owners in FCT, Nigeria, towards rabies (December 2014 to February 2015)

Variable N = 276		Frequency	Percentages [%]
Bite by suspected animal should be reported to the doctor	Agree	269	97.5
	Disagree	0	.0
	Indifferent	7	2.5
Rabies is of little importance to humans	Agree	34	12.3
	Disagree	208	75.4
	Indifferent	34	12.3
All dogs should be vaccinated against rabies	Agree	261	94.6
	Disagree	0	.0
	Indifferent	15	5.4
Vaccinating dogs yearly is not necessary	Agree	15	5.4
	Disagree	227	82.2
	Indifferent	34	12.3
It is wrong to allow dogs to roam	Agree	235	85.1
	Disagree	34	12.3
	Indifferent	7	2.5
Children must not play with stray animals	Agree	194	70.3
	Disagree	34	12.3
	Indifferent	48	17.4
Washing bite wounds with soap and water before medical help is necessary	Agree	178	64.5
	Disagree	41	14.9
	Indifferent	57	20.7

Table 8. Association of demographic variables to the categorized attitude towards rabies scores of dog owners in FCT, Nigeria (December 2014 to February 2015)

Categorical predictor variable	Positive attitude	Negative attitude	Likelihood ratio (LR)	Odds ratio	Confidence interval for OR (95 %)
Area of residence					
City centre (phases 1, 2, 3)	146 (73 %)	54 (27 %)	$\chi^2 = 20.54$ df = 1	0.284	0.164–0.492
Satellite towns/ Suburbs	33 (43.4 %)	43 (56.6 %)	P < 0.001	1	DV
Gender					
Male	154 (63.4 %)	89 (36.6 %)	$\chi^2 = 2.06$ df = 1	1.806	0.781–4.174
Female	25 (75.8 %)	8 (24.2 %)	P = 0.151	1	DV
Occupation					
Corporate institution personnel	112 (73.2 %)	41 (26.8 %)	$\chi^2 = 10.50$ df = 1	0.438	0.265–0.725
Traders	67 (54.5 %)	56 (45.5%)	P < 0.001	1	DV
Level of education					
Tertiary	168 (71.8 %)	66 (28.2 %)	$\chi^2 = 31.18$ df = 1	0.139	0.066–0.293
Primary/secondary	11 (26.2 %)	31 (73.8 %)	P < 0.001	1	DV

df — degree of freedom; DV — dummy variable (cells are redundant); P — P-value

rized attitude scores and area of residence of dog owners ($\chi^2 = 20.54$; df = 1; $P < 0.05$), occupation ($\chi^2 = 11.66$; df = 1; $P < 0.05$), and level of education ($\chi^2 = 54.78$; df = 1; $P < 0.05$) (Table 8). The odds ratios reflected the fact that dog owners in the satellite towns or suburban areas, males, traders, having not more than secondary or primary school leaving certificates had more respondents with negative attitude towards rabies prevention.

e) Practices of dog owners in FCT, Nigeria, towards rabies prevention

The mean practice score was 91.3 ± 21.39 % in a questionnaire with 6 items. Out of the 276 respondents, 213 (77.2 %) vaccinated their dogs against rabies, 254 (92 %) do take their dogs for clinical attention regularly and 254 (92 %) do not allow their dogs to roam. Two hundred and sixty-one (94.6 %) of the dog owners do not go for hunting with their dogs. All the respondents seek medical attention in the advent of a dog bite and 254 (92 %) keep a record of treatments administered to their dogs (Table 9).

f) Association of demographic variables of dog owners in FCT, Nigeria, to the categorized rabies prevention practice scores

There was a significant association between categorized practice scores and area of residence of dog owners ($\chi^2 = 26.43$; df = 1; $P < 0.05$), occupation ($\chi^2 = 16.20$; df = 1; $P < 0.05$), and level of education ($\chi^2 = 50.57$; df = 1; $P < 0.05$) (Table 10). The odd ratios reflected the fact that dog owners in the satellite towns or suburban areas, traders, having not more than secondary or primary school leaving certificates had more respondents with poor rabies preventive practices.

g) Association of rabies KAP scores of dog owners and the rabies antibody titre of dogs

Most, i.e. 171 (99.4 %) of the 172 dog owners with "Good" rabies knowledge scores had dogs with protective rabies antibody titres. Significant associations were observed between the rabies knowledge ($\chi^2 = 71.05$; df = 1; $P < 0.05$), attitude ($\chi^2 = 33.80$; df = 1; $P < 0.05$) and practice ($\chi^2 = 62.36$; df = 1; $P < 0.05$) scores (Table 11).

DISCUSSION

The zoographic information about the sampled dogs showed that a large proportion of the dogs were of exotic breed origin. This can be attributed to the aesthetic sentiment attached to owning foreign breeds of dogs and the relatively high cost of selling its offspring when compared to the indigenous breed of dogs. Most of the dogs were within 1—5 years of age which can be attributed to the agility and strength of the 1—5 years age group. Dogs acquired

Table 9. Rabies preventive practices of dog owners in FCT, Nigeria (December 2014 to February 2015)

Variable N = 276		Frequency	Percentages [%]
Do you vaccinate your dogs against rabies?	Yes	213	77.2
	No	63	22.8
Do you take your dog for clinical attention?	Yes	254	92.0
	No	22	8.0
Do you allow your dog roam?	Yes	22	8.0
	No	254	92.0
Do you take your dog for hunting?	Yes	15	5.4
	No	261	94.6
Do you seek medical attention in the advent of an animal bite?	Yes	276	100.0
	No	0	.0
Do you keep a record of treatments administered to your dog?	Yes	254	92.0
	No	22	8.0

Table 10. Association of demographic variables of dog owners in FCT, Nigeria, to categorized rabies preventive practice scores (December 2014 to February 2015)

Categorical predictor variable	Good practice	Bad practice	Likelihood ratio (LR)	Odds ratio	Confidence interval for OR (95 %)
Area of residence					
City centre (phases 1, 2, 3)	171 (85.5 %)	29 (14.5 %)	$\chi^2 = 26.43$ df = 1	0.209	0.115—0.382
Satellite towns/ Suburbs	42 (55.3 %)	34 (44.7 %)	P < 0.001	1	DV
Gender					
Male	187 (77 %)	56 (23 %)	$\chi^2 = 0.056$ df = 1	1.112	0.458—2.699
Female	26 (78.8 %)	7 (21.2 %)	P = 0.813	1	DV
Occupation					
Corporate institution personnel	132 (86.3 %)	21 (13.7 %)	$\chi^2 = 16.20$ df = 1	0.307	0.170—0.555
Traders	81 (65.9 %)	42 (34.1 %)	P < 0.001	1	DV
Level of education					
Tertiary	200 (85.5 %)	34 (14.5 %)	$\chi^2 = 50.57$ df = 1	0.076	0.036—0.16
Primary/secondary	13 (31 %)	29 (69 %)	P < 0.001	1	DV

df — degree of freedom; DV — dummy variable (cells are redundant); P — P-value

Table 11. Association of KAP scores and rabies antibody titre of dog owners in FCT, Nigeria (December 2014 to February 2015)

Categorical predictor variable	Protective titre frequency	Non-protective titre frequency	Likelihood ratio (LR)	Odds ratio	Confidence interval for OR (95 %)
Knowledge					
Good	171 (99.4)	1 (0.6)	$\chi^2 = 71.048$	0.011	0.001—0.082
Poor	68 (65.4)	36 (34.6)	P < 0.001	1	DV
Attitude					
Positive	171 (95.5)	8 (4.5)	$\chi^2 = 33.802$	0.110	0.048—0.252
Negative	68 (70.1)	29 (29.9)	P < 0.001	1	DV
Practice					
Good	205 (96.2)	8 (3.8)	$\chi^2 = 62.359$	0.046	0.019—0.108
Bad	34 (54)	29 (46)	P < 0.001	1	DV

df — degree of freedom; DV — dummy variable (cells are redundant); P — P-value

from friends or neighbours were predominant as they can be purchased at low prices from trusted sources. Most of the dogs were kept for security purposes because this is one of the chief reasons why people purchase dogs. Most of the dogs in phases 1, 2 and 3 had certified anti-rabies vaccination records whilst only 52.63 % of dogs in the satellite towns or suburban area had records of anti-rabies vaccination. The people most affected by rabid dog bites usually live in poor rural communities where medical resources are often sparse; these communities have problems that are often underscored by politicians and health authorities usually based in capital cities and are poorly informed about major public health issues affecting rural/suburban settlements [22]. This agrees with the study conducted in Abuja Municipal Area Council (city centre) where only 13.8 % of the dog owners had no evidence of anti-rabies vaccination of their dogs as documented by Edukugho [7]. Most of the exotic breed dogs had certified anti-rabies vaccination record whilst a meagre 22.9 % of the indigenous breed of dogs had anti-rabies vaccination record which is most likely since more care and attention is given to exotic breed of dogs by owners because of the high cost of purchasing them and the high returns to be generated from their litters.

There was an obvious decline in rabies antibody titre with increased time post anti-rabies vaccination with a marked decline after one year of vaccination (Figure 2). This can be attributed to the fact that rabies antibody titre wane with time, hence dog owners are advised to vaccinate their dogs against rabies yearly. The seroprevalence of rabies antibodies in FCT, Nigeria, was found to be 86.6 % with all exotic breeds having greater than 0.6 $EU.ml^{-1}$ whilst indigenous breed had the seroprevalence of only 22.9 %. This is at variance with the seroprevalence of rabies antibodies in Ilorin (Kwara State, Nigeria) where a seroprevalence of 49.1 % was observed in exotic breeds and 32.4 % was observed in the indigenous breed as documented by Aiyedun [2]. There was a significant association ($P < 0.05$) between the area of residence of dog owners in FCT, Nigeria and the antibody titre of the sampled dogs. This is probably since Abuja being the Federal Capital of Nigeria is a planned city with the upper social class residing mainly in the city centre (phases 1, 2, and 3), whilst the not so privileged reside in the satellite towns and suburban areas. The significant association between the occupation of dog owners in FCT, Nigeria, and the rabies antibody titre of dogs might be largely since the occupation is often a direct reflection of the level of education and traders are usually busy people having little or no time to vaccinate their dogs. There was a significant association ($P < 0.05$) between the number of dogs owned and the rabies antibody titre of dogs, as most of the dog owners with > 10 dogs were mainly commercial breeders, therefore they tried to keep their dogs as fit for sale as possible. The significant association between the education level and rabies antibody titre ($P < 0.05$) shown reflected the fact that the higher the level of education the more the likelihood of anti-rabies vaccination as education increases enlightenment about the dangers associated with not vaccinating dogs against rabies.

The association of dog breed to rabies antibody titre was significant, the cost of procuring exotic breed of dogs might be the major reason why dog owners pay more attention to their exotic breed of dogs and ensure their vaccination protocols are adhered to hence all the exotic breed of dogs had the required rabies antibody titre. This agrees with the seroprevalence of rabies antibodies in dogs in Ilorin (Kwara State, Nigeria) where there was significant association between the breed of the dogs and their rabies antibody titre with the exotic breeds having a higher seroprevalence than the indigenous breed as documented by Aiyedun [2]. A significant association between the age of dogs and their rabies antibody titre ($P < 0.05$) was observed, which might be due to the fact that more attention/care is usually given to newly acquired animals hence nearly all the dogs within 6 months to 5 years had the required rabies antibody titre (> 0.6 $EU.ml^{-1}$) and all the dogs older than 10 years of age also had their required rabies antibody titre as attachment to old dogs can also make dog owners pay more attention to their dogs. There was a significant association between the sex of dogs and their rabies antibody titre. This may probably be since male dogs are usually kept for security reasons and their vaccination protocol are thus adhered to. The association of the source of dogs and their rabies antibody titre was significant ($P < 0.05$), this might be largely since dogs acquired informally (from friends or neighbours) are less likely to be taken to clinics for proper veterinary attention than dogs acquired by importation or from commercial dog breeders. Worthy of note during this study was the fact that only one dog was certified vaccinated using the National Veterinary Research Institute (NVRI) vaccine and most of the veterinary clinics complained that this vaccine's availability is not commensurate to the demand for it in the market. The respondents in this study reflected

fair to good knowledge of rabies as it pertains to its mode of transmission and case fatality rate but their knowledge on the clinical signs of rabies was poor. This agrees with the study in Abuja Municipal Area Council where 82 % of the respondents had satisfactory knowledge about rabies but 54 % believed rabies could be cured after symptoms appear as documented by Edukugho [7]. Residents in the city centre were much more aware of good rabies knowledge, positive attitude and good rabies preventive practices than the residents in the suburban parts of FCT. Civil servants, private sector workers and students were also found to be more aware of better knowledge, attitude and practice than the traders. Residents with tertiary education were also more aware about rabies than respondents with only primary/secondary education.

There was a statistically significant association between the areas of residence, occupation, number of dogs owned, level of education and the knowledge of dog owners about rabies. This can be attributed to the structure of Abuja as a planned territory with most of the socially privileged and enlightened individuals residing in the city centre (FCT phases 1, 2, and 3) whilst the less educated or financially limited persons reside in satellite towns or suburban settlements. There was no statistically significant association between the gender of dog owners and their knowledge about rabies. This agrees with the study in Abuja Municipal Area Council as documented by Edukugho [7]. The respondents' attitude of promptly washing dog bite wound, reporting dog bite incidents to the doctor, vaccinating their dogs yearly, not permitting roaming of dogs, discouraging children from playing with stray dogs reflects their positive attitude towards rabies prevention. This agrees with the study documented by Edukugho [7] in Abuja Municipal Area Council where 74 % of the respondents had a positive attitude and 24 % had a fair attitude towards rabies. Good practices including vaccination of dogs, regular clinical evaluation, keeping record of treatments administered, show the importance the dog owners attach to rabies prevention. This is also in agreement with the result of the study documented by Edukugho [7] in Abuja Municipal Area Council where he documented that 75 % of the respondents had satisfactory practice and 25 % had fair practice towards rabies prevention. The analysis reflected the significant statistical association of knowledge, attitude and practice scores with anti-rabies vaccination status and this is largely due to the fact that educational enlightenment moves dog owners to seek rabies prevention by vaccination. This study reflects the need for mass enlightenment campaigns against rabies in Abuja, Nigeria placing emphasis on educating the residents on the clinical manifestations of the disease. Following this cross-sectional study conducted in FCT, Nigeria, within the period December, 2014 and February, 2015 to ascertain the antibody prevalence of dogs in Abuja against rabies it was observed that a majority (83 %) of the sampled dogs were vaccinated against rabies, all vaccinated dogs had rabies antibody titre > 0.6 $EU.ml^{-1}$, the rabies vaccination status of dogs in FCT satellite towns were unsatisfactory, hence mass vaccination of dogs in the satellite towns is recommended.

CONCLUSIONS

The Federal Capital Territory of Nigeria have enlightened residents with good knowledge as it pertains to rabies and its preventive measures. Their antirabies dog vaccination culture is commendable with the canine antirabies antibody titres largely protective. However, the suburban settlement pockets in the territory still contains large populations of unvaccinated dogs owned by poorly enlightened residents. These suburban settlements thus require prompt massive rabies enlightenment campaigns and vaccinations to lessen the likelihood of these areas serving as rabies nidus and reservoirs soon.

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