Factors associated with rabies immune status of dogs and anti-rabies vaccination of animal health workers in Kano Metropolis Nigeria

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KEYWORDS: Rabies, Antibodies, Dogs, Animal Health Workers, Kano, Nigeria

ABSTRACT

Introduction: Rabies, although a very fatal viral disease, is 100% preventable majorly through vaccination. There is therefore a need to ensure that vaccines induce sufficient antibody titre for protection in vaccinated animals. The purpose of the study was to determine factors that are associated with rabies antibody titre in dogs and the vaccination status of health workers in selected veterinary clinics within the Kano metropolis. **Methods:** We conducted a cross-sectional study. Using multistage sampling, we obtained sera from 150 apparently healthy dogs in three veterinary clinics. Demeditec Rabies IgG Ab (Dog) Enzyme-Linked Immunosorbent Assay (ELISA) kit was used to detect rabies anti-glycoprotein antibodies. A pretested semi-structured questionnaire was administered to 121 animal health workers in the selected clinics. Proportions, Adjusted Odds Ratios (AOR) and 95% Confidence intervals (CI) were calculated. **Results:** Sixty-seven (57.80%) of 116 vaccinated dogs and 12 (35.30%) of 34 unvaccinated dogs had rabies antibody titre <0.50IU/ml. Independent factors associated with unprotective rabies antibody titre were the interval between vaccination and time of sampling (aOR=2.35; 95%CI: 1.6 to 5.39) and the vaccination status (aOR:5.54; 95%CI: 1.12 - 12.31) of dogs. From the 121 health workers interviewed, 30 (24%) had a complete vaccination history, 20 (17%) had a history of dog bites and 32 (27%) were veterinary doctors. The vaccination status of health workers was significantly associated with having a history of dog bites (aOR: 0.17; 95%CI: 0.05 - 0.503) and being a veterinary doctor (aOR: 0.12; 95%CI=0.04 - 0.32). **Conclusion:** Factors associated with the immune status of dogs were the interval between vaccination and time of sampling and the vaccination status of dogs; while determinants of the vaccination status of animal health workers were the history of dog bites and a cadre of staff. We recommended consistent annual mass rabies vaccination of dogs and conduct of public awareness on the importance of anti-rabies vaccination. All cadres of animal health workers should be sensitized and encouraged to get rabies pre-exposure prophylaxis.

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RECEIVED
05/02/2021

ACCEPTED
24/04/2024

PUBLISHED
29/04/2024

LINK

www.afenet-journal.net/content/article/7/22/full

CITATION
Visa Ibrahim Tyakaray et al . Factors associated with rabies immune status of dogs and anti-rabies vaccination of animal health workers in Kano Metropolis Nigeria. J Interval Epidemiol Public Health. 2024 Apr 29; 7(2): 6
DOI:
https://www.doi.org/10.37432/jieph.2024.7.2.113

Introduction

Rabies, a widespread neglected and under-reported zoonosis has become a global public health threat particularly in Africa and Asia [1]. In Nigeria, public concerns and fears are mostly focused on dogs as the major source of rabies [2]. The prevalence of rabies in Nigeria is 15-20%; however, because of the problem of underreporting, the true picture is difficult to obtain [3, 4]. Canine rabies is endemic in Kano State with several frequently reported outbreaks of dog bites within the metropolis and also in some of the LGAs in the northern part of the State [5]. Being almost 100% preventable, effective tools and methods exist to prevent the spread of canine rabies to humans. The most practical and cost-effective way to end canine rabies is mass dog vaccination; which saves the lives of both dogs and humans [6]. Vaccination plays an important role in the protection of man and animals against rabies [7]. Vaccinating dogs against rabies is to establish pre-exposure immunity and protect animals from contracting rabies, thereby preventing further spread to humans or other domestic animals.

In Nigeria, rabies is mainly controlled through regular vaccination of dogs by the use of high and/or low egg passage flurry strain of the virus as vaccine produced by the National Veterinary Research Institute Vom, Nigeria [8, 9]. Vaccinating more than 70% of dog population would be sufficient to create an immunological barrier that prevents the spread of the rabies virus [10]. Mainly, the G protein is utilized for ideal anti-rabies vaccine preparation due to its purity and potency. It is the structural protein of the virus that induces the formation of antibodies which confers immunity to animals [11]. Vaccine-induced protection from rabies may be compromised for several reasons. These include: insufficient vaccine delivery during vaccination campaigns, poor vaccine handling practices, lack of consistent vaccination campaigns and the possibility of immuno-suppression through malnutrition, infection or other stressors which may reduce the proportion of dogs that seroconvert or the duration of immunity in vaccinated dogs [12].

Pre-exposure rabies prophylaxis (PrEP) is recommended by the World Health Organization for anyone who is at continual, frequent or increased risk of exposure to the rabies virus, as a result of their occupation such as laboratory staff, veterinarians, animal handlers and wildlife officers [13]. Recommended PrEP regimen could be given via intramuscular route (One intramuscular dose is given on each of days 0, 7 and 21 or 28 at the deltoid area of the arm for adults and anterolateral area of the thigh for children aged less than 2 years) or via intradermal route (One intradermal injection of 0.1 ml is given on each of days 0, 7, and 21 or 28); however, if antimalarial chemoprophylaxis is applied concurrently, intramuscular injections must be used.

Animal health workers are at risk of exposure to rabies virus. Humans can be infected when an infected animal's saliva gets through an open wound (usually the animal's bite) or through a mucous surface such as the eyes, nose, or mouth [14]. Professionals play an important role in promoting public health through recognition and treatment of diseases in companion and food animals and through education of clients about diseases that may be transmitted from pets and livestock to humans [15, 16]. Because veterinarians are often the first to encounter potentially infective animals, they and their staff are at risk of contracting zoonotic infections and may serve as the first line of defense or as a bridge for disease entry into the human population [17]. This study was conducted to determine factors influencing rabies antibody titre in dogs and to identify factors associated with pre-exposure vaccination status of animal health workers in veterinary clinics within Kano metropolis, Nigeria.

Methods

Study Area

The State consists of 44 Local Government Areas (LGAs), and three geopolitical zones and the Kano metropolitan zone consists of eight LGAs (**Figure 1**).

Study Design

The study design employed was a cross-sectional study carried out from July 2017 to January 2018.

Study Population

According to the 2006 census figures from Nigeria, Kano State had a population totalling 9,383,682 [18], however the population of dogs in Kano State is unknown. The metropolis has three government

owned and three registered private veterinary clinics evenly distributed within the metropolis. The study population consisted of dogs presented at the veterinary clinics and animal health workers working in the clinics. Puppies younger than three months of age and severely sick and unconscious dogs were excluded from the study [19].

Sample Size

The sample size for determining antibody titre in dogs was determined using the formula by Lwanga & Lemeshow (1991). Using the prevalence of rabies antibodies of 8.8% [20], the sample size of 150 was used.

A population study was conducted among all the 121 animal health workers in the three selected veterinary clinics where semi-structured questionnaires were administered to collect socio-demographic information, anti-rabies vaccination status and years of occupational exposure.

Sampling Technique

To determine the rabies antibody titre, multistage sampling technique involving 3 stages was used to select the dogs presenting at the veterinary clinics:

First stage: 3 Local Government Areas (LGAs) were selected randomly by balloting from the LGAs in Kano metropolis.

Second stage: one Veterinary clinic was selected at random from each LGA using balloting without replacement.

Third stage: All eligible dogs presented to the veterinary clinics were systematically sampled. First, the sample size for each facility was allocated based on the proportion of dogs presented to the facility per week by the total estimated sample size. The sampling interval was calculated by dividing the total estimated sample size (150) by number of dogs presented to the three clinics per week (62) giving 2.42; therefore, the sampling interval of nth = 2 was used until the estimated sample size was reached.

Data Collection

A semi-structured questionnaire was used to collect demographic information of dogs from dog owners after informed consent were obtained from each respondent and their confidentiality assured. Blood sample was collected from each participating dog.

Laboratory Investigation

A total of 150 sera were processed from blood samples collected from dogs presented to three veterinary clinics: Gwale, Kundilla and PHED veterinary clinics. After proper restraint, sterile needles and syringes were used to collect 2.5-5mls of blood samples from the cephalic vein of dogs into plain labelled sample bottles (without anticoagulant) and allowed to clot. All dogs were released after sample collection. Sera was obtained by centrifuging at 3000rpm and temporary stored at -40C until the test was conducted. The Demeditec Rabies IgG Ab (Dog) ELISA kit for determining antibodies against epitopes of serum samples was used in this study. All steps were conducted according to the manufacturer's instructions and results were read using ELISA reader (Uniequip®USA). The Optical density readings of the test wells were read using a monochromatic plate reader at 450nm. The rabies antibody titre of sampled dogs were then deduced [21].

Statistical Analysis

Data collected were entered, cleaned and analysed in Microsoft Office Excel (Version 2016) and Epi-Info (Version 7.2). Demographic variables were presented using descriptive statistics. Bivariate analysis was conducted to assess the associations between the dependent variable (serological response $\geq$ 0.50 IU/ml or $<$ 0.50 IU/ml) and the independent variables as well as the association between the vaccination status of health workers and independent factors. Multiple logistic regression model was performed to control for confounders.

The outcome variables were the anti-body titre level of dogs and the vaccination status of health workers. Independent variables for dogs include the age of the dog, sex of dog, breed of dog, age at last vaccination, day of sampling after last vaccination, brand of vaccine and number of vaccinations. Independent variables for animal health workers were: age of

animal health worker, sex, anti-rabies vaccination status of animal health worker and years of exposure.

Fully vaccinated animal health worker was an animal health worker who had received three doses of rabies pre-exposure prophylaxis on days 0, 3 and 21/28 or post-exposure prophylaxis on days 0, 3 and 14.

Ethical considerations

Ethical approval was obtained from the ethical committee of the Kano State Ministry of Agriculture and Natural Resources (Veterinary department). Written informed consent of respondents in the study was obtained and respondents were assured of confidentiality of information supplied. We minimized discomfort while collecting blood sample.

Results

Demographic characteristics of Dogs

A total of 150 dogs were sampled from three veterinary clinics within Kano metropolis. Of the 70 dogs sampled from Gwale Clinic, 55(78.60%) were vaccinated. In Kundilla clinic, 47 dogs were sampled of which 37 (78.70%) were vaccinated while out of the 33 dogs sampled at PHED clinic, 24 (72.70%) were vaccinated. Sixty-nine (46.00%) dogs were kept for security purpose, 6 (4.0%) as pets and 75 (50.00%) for hunting. The median age of the dogs was 3.75 years (IQR = 3 - 4.5) and 40.4% (60/150) were within the 1-5 years´ age group; with 123 (82.00%) being females and 133 (88.00%) were of the indigenous breed (Table 1).

Association between Demographic Characteristics of dogs and Protective antibody titre

Out of the 150 dogs sampled, 72 (53.74%) of the 134 indigenous breed of dogs and 9 (56.25%) of the 16 exotic breed had rabies protective antibody titre (>5.0IU/ml) while 62 (46.26%) of indigenous dogs and 7 (43.70%) of exotic breed had unprotective antibody titre (<5.0IU/ml). Dogs under one year of age with protective rabies antibody titre were 45 (62.50%) and 25 (44.45) of the 22 dogs >1 year had Protective rabies antibody titre while 27 (37.50%) of dogs <1 year and 52 (67.50%) of dogs >1 year have unprotective antibody titre of <5.0IU/ml. Vaccination status reflected that 49 (42.20%) of 116 vaccinated and 22 (64.70%) of the 34 unvaccinated dogs had rabies antibody titre <0.5IU/ml while 67 (57.80%) of vaccinated dogs and 12 (35.30%) of unvaccinated dogs had unprotective antibody titre of <5.0IU/ml. For the brand of vaccine used, 42 (68.90%) of dogs vaccinated with locally produced or indigenous vaccines (NVRI) and 57 (82.60%) of those vaccinated with foreign Vaccines (Forte dodge and Biocan), had rabies antibody titre <0.50IU/ml while 51 (68.90%) of dogs vaccinated with local vaccine and 59 (82.60%) vaccinated with foreign vaccine had unprotective antibody titre of <5.0IU/ml. Significant association was observed in age [Odds Ratio (OR) = 3.46; Confidence Interval (CI) = 1.77to 6.81], Vaccination history (OR = 2.56; CI = 1.13 to 5.56), and interval from last vaccination to the time of sampling (OR = 2.98; CI = 1.39 to 6.40) with protective rabies antibody titre of dogs (Table 2).

Factors Associated with of Protective rabies antibody titre of Dogs

Independent factors associated with unprotective rabies antibody titre were: Interval from vaccination to sampling (Post-vaccination period) (Adjusted Odds Ratio (AOR) = 2.35,CI= 1.60 to 5.39) and vaccination status of dogs (AOR= 5.54; CI = 1.12 to 12.31) (Table 3).

Socio-demographic Characteristics of Animal Health Workers

Of the 121 animal health workers interviewed, 83 (68.60%) were from Gwale clinic, 20 (16.50%) from PHED and 18 (14.90%) from Kundila clinic. Mean age of respondents was 24±2 years with males being 104 (85.90%). Of these animal health workers, 69 (77.50%) had worked for <5 years while 5 (5.60%) worked for >20 years. History of bite revealed 20 (16.50%) of animal health workers had ever been bitten. From the 30 fully vaccinated health workers, 10 (33.30%) were vaccinated <1 year from the time of interview (Table 4).

Association Between Socio-demographic Characteristics of Animal Health Workers and their Vaccination Status

From the 101 government animal health workers interviewed, 28 (27.70%) were vaccinated with 76 (72.30%) unvaccinated, whilst 6 (60.00%) animal health workers from private clinic were vaccinated and 4 (30.00%) were not fully vaccinated against rabies. Out of the 32 Veterinary doctors interviewed, 18 (56.25%) were fully vaccinated and 14 (43.75%) were not fully vaccinated whereas 12 (13.64%) of the 88 other animal health workers were fully vaccinated and 76 (86.40%) were not fully vaccinated against rabies. Animal health workers were categorized into two groups by age, of which 104 health workers were <35 years, 25 (24.00%) in that age group were vaccinated and 79 (75.90%) unvaccinated whereas for those in >35 years´ age group 5 (29.40%) were vaccinated and 12 (70.60%) were unvaccinated. Twenty-seven (26.20%) of the 103 male health workers were vaccinated whilst 3 (16.70%) of the 18 female animal health workers were fully vaccinated. Animal health workers with history of <5 Years work duration in the clinic were found to be 83 out of which 23 (33.30%) were vaccinated and 63 (66.70%) were unvaccinated while 20 had worked for >5 years of which 18 (17.80%) were fully vaccinated and 21 (80.00%) unvaccinated and 8 (40.00%) unvaccinated. A total of 20 animal health workers had history of dog bite out of which 12 (60.00%) were fully vaccinated. There was a statistically significant association between the type of veterinary clinic (OR = 0.26; CI = 0.07 to 0.97), Cadre of staff (OR = 0.13; CI = 0.05 to 0.31), history of dog bite (OR = 6.92; CI = 2.47 to 11.36) and the vaccination status of animal health workers (**Table 5**).

Predictors of the Vaccination Status of Animal Health Workers

History of dog bite and cadre of staff were found to be a statistically significant independent factors (Predictor) of the vaccination status of animal health workers in Veterinary clinics. Animal health workers who had never been bitten by a dog were less likely to be full vaccinated compared to those who had ever been bitten (AOR = 0.17; 95% CI = 0.05 to 0.503). In addition, other cadres of animal health staff were less likely to be full vaccinated compared to veterinary doctors (AOR = 0.12; 95% CI = 0.04 to 0.32) (**Table 6**).

Discussion

Findings from this study showed that more than 50% of dogs sampled in all the three clinics were previously vaccinated. This could be due to the high level of education and awareness of the residents of this metropolitan areas on the fatal nature of rabies which is similar to findings in Taraba, Nigeria and Tanzania where majority of respondents with high knowledge of rabies were educated ones living in urban areas [**22, 23**] . Also findings show that majority of animal health workers had no anti-rabies vaccination history with a greater proportion of vaccinated animal health workers being veterinarians. This could be due to the fact that most Veterinarians are better aware of the importance of anti-rabies prophylaxis than other category of animal health worker [**33**,**36**].

Majority of sampled dogs for this study were from the Gwale Veterinary clinic, which could be attributed to the reality that this clinic is one of the largest and the most patronized veterinary clinic in Kano State. Demographic information shows that most dogs sampled were local, which are indigenous to the people; other studies in Nigeria have shown that majority of dog population in some Nigerian cities are local breed [**5**,**8**]. The main purpose of keeping dogs by respondents was for hunting and as security or guard dogs. This maybe because of the relatively low cost involved in their management [**24, 25**]. In previous studies in Abuja and Namibia, dog ownership is reported to be majorly for the purposes of security and hunting which could be because dogs within the metropolis are predominantly kept for hunting and/or security purposes [**4, 10**]. Majority of vaccinated dogs sampled had high protective antibody titre which could be as a result of immune response to vaccination; thereby stimulating antibody production which confers immunity for protection against the rabies viral antigen [**12**].

Vaccination status of dogs was found to be significantly associated with antibody response, indicating that the odds of having protective rabies antibody titre was about three times more likely in vaccinated dogs than in dogs not vaccinated. This

implies that vaccination stimulates antibody response thereby raising the titre and conferring immunity. This was in agreement with other studies in India, Tunisia and in Ilorin, Nigeria [26, 27]

The interval between vaccination and the time of sample collection was found to be statistically significant which implies that vaccinated dogs with <1 year interval from vaccination to time of sample collection are three times more likely to develop protective antibody titre than those with >1 year duration which can be attributed to the fact that antibody titre decreases with time. This is in keeping with a study in France where there was a strong correlation between antibody titre and the time elapsed between the last vaccination and blood sampling as well as from a study conducted in Botswana [28, 29] .

Dogs sampled in this study did not achieve protective titre. Indicating an obvious decline in rabies antibody titre with increased time post anti-rabies vaccination (>1 year) which could be attributed to the fact that rabies antibody titre wanes with time and hence the need for the annual booster vaccination [30, 31]. Likewise, studies in Botswana, Sri Lanka and Ibadan showed significant association between post-vaccination period and protective rabies antibody titre, where majority of dogs with long post-vaccination period had low rabies antibody titre [28, 31-32].

Results of this study indicates that a large proportion of the at-risk staff working in veterinary clinics, had not received rabies pre-exposure vaccination as recommended by WHO guideline on pre-exposure prophylaxis. This could be as a result of knowledge gap, as most of these staff are of lower cadre with few years of experience or as a result of high cost and scarcity of the vaccine for the rabies pre-exposure prophylaxis as observed in a study in Nigeria, where most of those occupationally exposed could not afford and easily access the vaccine [33]. The Pre-exposure prophylaxis is recommended for anyone who is at continual, frequent or increased risk of exposure to the rabies virus, as a result of their occupation or residence such as, laboratory staff, veterinarians, animal handlers and wildlife officers [34].

There was significant association between the cadre of staff and vaccination status, which implies that veterinary doctors were more likely to get vaccinated than other cadre of staff in the clinic. This may be due to the fact that veterinarians are more knowledgeable of the high risk of exposure to rabies in the work place. This finding corroborates with the results of a study in Minnesota and in Veterinary Colleges where majority of respondents were Veterinarians [35, 36]. In addition, history of dog bite was significantly associated with vaccination status of health workers. This infers that a health worker with history of dog bite is more likely to get vaccinated against rabies than one with no history of dog bite. A possible reason behind this could be fear of possible exposure to rabies through bite. This is supported by studies in the US and Pakistan which revealed an increased likelihood of pre-exposure prophylaxis in individuals exposed to dog bite [37, 38].

The unavailability of vaccination records of some the dogs was a limitation; we therefore relied on verbal information which could lead to recall bias. However, to minimize this we used memory aids and events that make the respondents remember vaccination history. Another limitation is that the data relied only on the dogs that visited the animal health workers which are more likely to be vaccinated making it difficult to generalize to the community and finally we could not disaggregate the analysis further due to the way the data was coded.

Conclusion

A large proportion of dogs presented to the veterinary clinics within Kano metropolis were vaccinated but with a lower proportion of the vaccinated dogs having unprotective antibody titre (>0.50 IU/ml), with most of them having long interval between vaccination. Majority of the dogs were vaccinated with low egg passage (LEP) flurry strain vaccine produced by NVRI. Independent factors influencing level of rabies antibody titre in dogs were vaccination and the time interval between vaccination and blood sampling. Majority of animal health workers had no anti-rabies vaccination history with a greater proportion of vaccinated animal health workers being veterinarians. History of dog bite is a factor associated with the vaccination status of animal health workers.

We sensitized the public by creating awareness on the importance of dog vaccination and encouraged responsible dog ownership through consistent annual vaccination.

We recommended the State Veterinary Department to increase awareness of health workers based on the WHO recommendation on pre-exposure prophylaxis of occupationally at-risk individuals. Also, the State government and private employers of animal health workers were encouraged to provide regular rabies vaccination to their staff.

What is known about this topic

- Significant association between vaccination status of dogs and antibody titre
- Significant association between vaccination status of animal health workers and the cadre of staff

What this study adds

- Association between dog bite and vaccination history of animal health workers in Kano state
- Majority of dogs sampled had long interval between vaccination period indicating most dogs are not regularly being vaccinated in Kano state.

Competing interests

The authors declare no competing interests.

Non-financial Competing Interests

This study was supported by Cooperative Agreement Number NU2GGH001876 funded by the United States Centers for Disease Control and Prevention through African Field Epidemiology Network to the Nigeria Field Epidemiology and Laboratory Training Programme. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the United States Centers for Disease Control and Prevention or the Department of Health and Human Services.

Authors' contributions

TIV designed the study, collected, analyzed, interpreted the data and wrote draft manuscript. JK and GSNK supervised the study, GU reviewed the manuscript for intellectual content. All authors read and agreed to the final version of the manuscript.

Acknowledgements

Special thanks to the supervisors of this work and the Nigeria Field Epidemiology and Laboratory Training Program for technical support. We also acknowledge all mentors from the African Field Epidemiology Network Nigeria Country office and the Department of Veterinary Public Health and Preventive Medicine, Ahmadu Bello University, Zaria.

Tables and figures

Table 1: Demographic Characteristics of some vaccinated Dogs in Kano Metropolis, Nigeria (August-December, 2018)

Table 2: Association Between Demographic Characteristics of dogs and Protective antibody titre

Table 3: Independent risk factors of unprotective rabies antibody titre of dogs in Kano Metropolis Nigeria, August-December, 2018

Table 4: Socio-demographic Characteristics of Animal Health Workers in Kano Metropolis, Nigeria (August-December, 2018)

Table 5: Association between Socio-demographic Characteristics of Animal Health Workers and their Vaccination Status

Table 6: Independent Predictors of the Vaccination Status of Animal Health Workers in Kano Metropolis Nigeria, July 2017 - January 2018

Figure 1: Map of the Study Area

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Table 1: Demographic Characteristics of Dogs Sampled at Veterinary Clinics in Kano Metropolis, Nigeria (July2017- January, 2018)

Dog's Profile	**Total Number (n=150)**	**Percentages (%)**
Age		
3-6 months	54	36.0
>6-12 months	18	12.0
>1-5 years	60	40.0
>5-10 years	15	10.0
>10 years	3	2.0
Sex		
Male	27	18.0
Female	123	82.0
Clinics		
Gwale	70	46.7
Kundila	47	31.3
PHED	33	22.0
Purpose of Dog		
Security	69	46.0
Pet	6	4.0
Hunting	75	50.0
Breed of Dog		
Local	132	80.0
Alsatian	14	9.3
Terrier	4	2.7
Vaccination status		
Yes	116	77.3
No	34	22.7
Brand of Vaccines		
NVRI	77	51.3
Fort Dodge	15	10.0
Biocan	55	36.7
Others	3	2.0
Time Interval after last Vaccination (Years)		
<1	104	69.4
1-2	38	25.3.0
3-4	8	5.3
Antibody Titre		
Protective (>0.50)	68	45.3
Unprotective (<0.50)	82	54.7

Table 2: Association Between Demographic Characteristics of dogs and Protective antibody titre at bivariate level					
Categorical Variable	**Protective antibody titre Frequency (%)**	**Unprotective antibody titre Frequency (%)**	**Odds Ratio (Unadjusted)**	**Confidence Interval**	**p-value**
Breed of Dog					
Exotic*	9 (56.25)	7 (43.75)	1		
Local (Indigenous)	72 (53.73)	62 (46.27)	1.09	0.38-3.09	0.873
Age (Years)					
<1	46 (62.50)	27 (37.50)	1		
≥1	25 (32.50)	52 (67.50)	3.46	1.77-6.81	<0.001
Sex					
Male	70 (56.90)	53 (43.10)	1		
Female	12 (44.40)	15 (55.60)	0.61	0.26-1.40	0.239
Vaccination Status					
Vaccinated	49 (42.20)	67 (57.80)	1		
Unvaccinated	22 (64.70)	12 (35.30)	0.42	0.18-0.95	0.021
Brand of Vaccine					
NVRI	26 (56.7)	51 (68.90)	1		
Foreign (Imported)	14 (17.40)	59 (82.60)	02.15	0.94-4.9	0.066
Interval from last Vaccination (Years)					
≤1	59 (56.70)	45 (43.30)	1		
>1	14 (30.40)	32 (69.60)	2.98	1.39-6.40	0.004
***Exotic Breeds:** Breeds of dogs foreign to Nigeria (Alsatian and Terrier)					

Table 3: Independent risk factors of unprotective rabies antibody titre of dogs at multivariate level, in Kano Metropolis Nigeria, July 2017 – January 2018

Predictors	**Adjusted Odds Ratio**	**95% Confidence Interval**
Age of Dogs (<1/≥1)	2.03	0.93-4.46
Interval from last Vaccination (>1/≤1)	2.35	1.60-5.39
Vaccination Status (Unvaccinated/Vaccinated)	5.54	1.12-12.31

Table 4: Socio-demographic Characteristics of Animal Health Workers in Kano Metropolis, Nigeria (July 2017 – January 2018)

Socio-demographic Profile	Total number (n=121)	Percentages (%)
Age (Years)		
15-24	54	44.60
25-34	50	41.30
35-44	8	6.60
45-54	7	5.80
>55	2	1.70
Sex		
Male	103	85.10
Female	18	14.90
Cadre of Staff		
Veterinary Doctor	32	26.40
Animal Scientist	21	17.40
Student	57	47.10
Animal handler/Kennel Cleaner	11	9.10
Clinic		
Kundila	18	14.90
Gwale	83	68.60
PHED	20	16.50
Health worker bitten by dog		
Yes	20	16.50
No	101	83.50
Duration of work in clinic (Years)		
1-5	94	77.70
6-10	16	13.20
11-15	1	0.80
16-20	3	2.50
>20	7	5.80
Fully Vaccinated against Rabies		
Yes	41	33.9
No	80	66.1
Interval from last Vaccination (Years)		
1	39	32.20
2	35	29.00
>3	24	19.80
Not Vaccinated	23	19.00

Table 5: Association between Socio-demographic Characteristics of Animal Health Workers and their Vaccination Status at bivariate level

Categorical Variable	Vaccinated Health Workers Frequency (%)	Unvaccinated Health Worker Frequency (%)	Odds Ratio	Confidence Interval	p-value
Veterinary Clinic					
Government	34 (27.70)	76 (72.30)			
Private	7 (60.00)	4 (30.00)	0.26	0.07-0.97	0.035
Cadre of Staff					
Veterinary Doctor	19 (59.40)	13 (0.60)			
Others	11 (12.40)	78 (87.60)	0.13	0.05-0.31	<0.001
Age (Years)					
<35	25 (24.00)	79 (75.90)			
≥35	5 (29.40)	12 (70.60)	0.76	0.24-2.37	0.634
Sex					
Male	27 (26.20)	76 (73.80)			
Female	3 (16.70)	15 (83.30)	1.77	0.48-6.62	0.556
Marital Status					
Single	22 (24.40)	68(75.60)			
Married	8 (25.80)	23 (74.20)	0.93	0.36-2.37	0.879
Duration of work					
≤5	25 (263.30)	70 (73.70)			
>5	5 (20.00)	21 (80.00)	2.00	0.59-6.67	0.407
History of dog bite					
Yes	12 (60.00)	8 (40.00)			
No	18 (17.80)	83 (82.20)	6.92	2.47-11.36	<0.001

Table 6: Independent Predictors of the Vaccination Status of Animal Health Workers at multivariate level, in Kano Metropolis Nigeria, July 2017 - January 2018

Independent Variable	Adjusted Odds Ratio	95%Confidence Interval
History of Dog Bite (Bitten/Not bitten)	0.17	0.05-0.503
Cadre of Staff (Vet. Doctors/Others)	0.12	0.04-0.32
Type of Clinic (Government/Private)	2.16	0.63-7.43

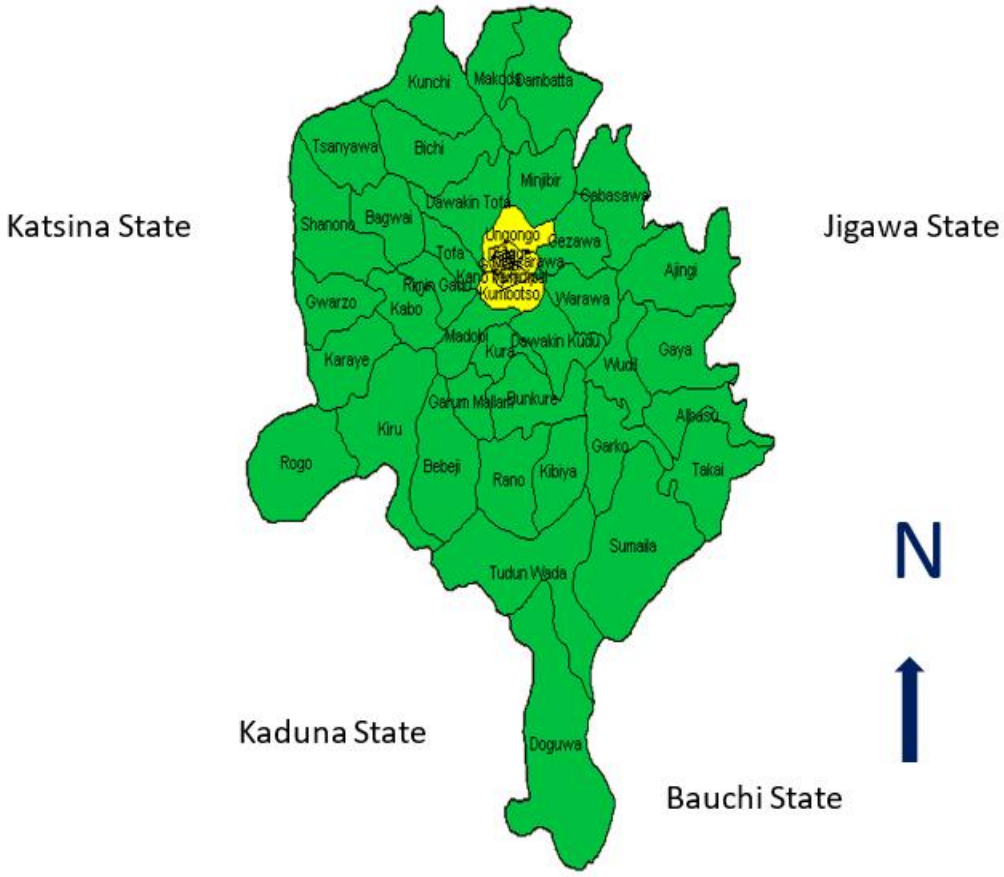

Figure 1: Map of the Study Area