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A cross-sectional study on antirabies vaccination exercise commemorating the World Rabies Day Celebration 2024 in Plateau State, Nigeria: breaking rabies boundaries

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Abstract

Introduction: *the World Rabies Day (WRD) celebration 2024 tagged "Breaking Rabies Boundaries" was commemorated globally to achieve zero cases of dog-mediated-human rabies by 2030. We determined the demographic features of vaccinated dogs, estimated dog population, and vaccination coverage rate in Plateau State.* ***Methods:*** *we conducted a cross-sectional study of the antirabies-vaccinated dogs in Plateau State using the mass vaccination data (7 days) to commemorate the 2024 WRD celebration in Plateau State. Data were collected using kobocollect and an online Excel spreadsheet. Variables extracted were; local government area (LGA), number of dogs per LGA, number of dogs vaccinated per household, number of people per household, age, sex, breed purpose of dog breeding, and management system. Reports on field challenges were collated. Data was analyzed using Microsoft Excel and QGIS version 3.16.* ***Results:*** *a total of 2949 dogs were administered antirabies vaccination, of which 54.5% were females. The vaccination coverage was 0.54%, with an estimated dog population of 542,810. The human-to-dog ratio was 4.6: 1, while the ratio of dogs per household was 1.5: 1. Jos North LGA had the highest number of vaccinated dogs, 570/2949 (19.3%). The major purpose of dog breeding reported was security, 71.8% (2116/2949), while local breeds were the majority, 93.3% (2750/2949). Dogs between the ages of 7 months to 3 years were the majority, 62.1% (1831/2949) among the age groups. The majority (88.7%) of dogs were under a semi-intensive management system. Challenges encountered during the vaccination exercise were; late and limited vaccine supply on the first day; limited resources for mobility during the vaccination exercise, hence, limiting mobility; poor mobilization for the exercise in most of the LGAs compelling teams to embark on house-to-house antirabies vaccination which was time-consuming and laborious, and limited time for the antirabies vaccination coverage.* ***Conclusion:*** *this study indicates that only 0.54% of the dogs were vaccinated in Plateau State to commemorate the WRD 2024, indicating the need to intensify the vaccination throughout the year for greater coverage. To achieve zero cases of dog bites by 2030, we recommend regular mass vaccination of dogs in all the states in the country with a special focus on rabies high-risk areas.*

Introduction

Rabies is a highly infectious disease of all warm-blooded animals, transmitted through bites from rabid animals. It is a viral, zoonotic, neglected tropical disease and a vaccine-preventable disease occurring in more than 150 countries [1]. Annually, about 59,000 people die due to the disease, and most of these casualties are from Africa and Asia [1]. Ninety-nine percent of human rabies cases are due to bites from infected dogs, with over 95% of deaths occurring in Africa and Asia [1,2]. Also, the majority of deaths (40%) occur in children (4 out of 10 rabies deaths) [1,2]. Over 80% of rabies cases have been reported to occur in rural areas [2]. Once the virus infects the central nervous system and clinical symptoms appear, rabies is fatal in 100% of cases. Rabies causes an estimated cost of USD 8.6 billion per annum globally [3].

World Rabies Day (WRD) was first celebrated in 2007 and is coordinated by the Global Alliance for Rabies Control (GARC). Annually, the event is celebrated every 28th of September to raise awareness about dog-mediated-human rabies and its control measures [3]. Dog-mediated-human rabies is targeted for elimination by the year 2030. The year 2024 theme for the commemoration of the WRD was titled "breaking rabies boundaries". As the eighteenth WRD was globally celebrated,

the quadripartite agencies, the Food and Agriculture Organisation of the United Nations (FAO), the World Organisation for Animal Health (WOAH), the United Nations Environmental Programme (UNEP) and the World Health Organisation (WHO), with the Global Alliance for Rabies Control (GARC), appealed to all stakeholders in Africa to reflect on the annual theme [4].

Nigeria has a 12.29% national vaccination rate as estimated by GARC indicating that much needs to be done to arrive at the 70 to 80% vaccination rate required for herd immunity [1,5]. Studies from 1978 to 2020 conducted in Nigeria showed that the prevalence of rabies virus antigen detection varied between 3% and 28% [6]. A recent estimation of the dog population in Nigeria was 12,969,368, reiterating that at least 9.1 million dogs must be vaccinated annually to attain sufficient herd immunity and dog rabies control in Nigeria [7]. Most bites by rabid dogs have been reported to be unprovoked (36.4%-97%). Studies have also indicated the low rate (6%) of laboratory confirmation of rabies for biting dogs [6]. Records of human deaths from 10 states in Nigeria between 1980 and 2014 have indicated a total of 78 reported deaths [8]. However, this can be said to be the tip of the iceberg of rabid deaths nationwide, giving the prevalence of the disease and the poor reporting system at the various Health Centres nationwide.

Plateau State being one of the high-risk areas for rabies in the country was selected for the WRD celebration 2024. On the Plateau, dogs are used for various purposes such as breeding, security, pets, hunting, and consumption as a source of protein and are exported to other countries as a means of income generation. Furthermore, some of the most flourishing Dog markets in Nigeria are located in the State. The largest dog market in the country is located at Dawaki in Kanke LGA of Plateau State [9]. The market is populated by dogs from all the northern states of the country and the Niger and Chad Republics [10]. The market transaction in 2017 generated about 3 million naira weekly [9]. The paucity of demographic data on dogs in Plateau State as well as relevant data such as the estimated number of dogs in the State makes this study relevant. Our research questions were (i) what is the antirabies vaccination rate among dogs in Plateau State during the WRD celebration 2024? (ii) what are the demographic features of antirabies-vaccinated dogs in Plateau State? (iii) what are the average human-to-dog ratio and household-to-dog ratio in Plateau State? The objectives of the study were to determine the; (i) antirabies vaccination coverage rate for the WRD celebration; (ii) demographic features of antirabies vaccinated dogs, (iii) human-to-dog ratio and household-to-dog ratio in Plateau State.

Methods

Study area: Nigeria (Figure 1) is composed of a land mass area of 923,769 square kilometers (356,669 square meters and shares land borders in the north with Niger, northeast with Chad, eastern border with Cameroon, and Benin in the west [11]. The projected population for Nigeria in 2022 was 216,783,381 comprising 108,350,410 males and 108,432,971 females [12] while Plateau State has a total population of 4,717,305 (males 2,308,911 and females 2,408,394) and estimated number of 361,873 households. Nigeria's dog population is estimated at 12,969,368 [12].

Study design: the 7-day field activity which started on Monday, 30th September to Sunday 6th October 2024 was coordinated by the Federal Department of Veterinary and Paste Control Services (DVPCS), Federal Ministry of Agriculture and Food Security (FMAFS), in collaboration with the Food and Agriculture Organisation of the United Nations-Emergency Centre for Transboundary Animal Diseases (FAO-ECTAD). Ensuring the success of the activity, a modified live attenuated low-egg passage antirabies vaccine produced by the National Veterinary Research Institute, Vom, Plateau State was procured by FAO-ECTAD and DVPCS. Furthermore, field equipment and consumables were supplied to each group Team

Lead accordingly. Provision was also made for logistical support for the campaign. Team movement was based on an itinerary design and shared with each team member prior to the commencement of the field activities (Figure 2).

World Rabies Day Celebration flag off of the mass antirabies vaccination campaign was at the Veterinary Teaching Hospital, University of Jos, and subsequently in all the seventeen (17) local government areas (LGAs) of the State. To support effective dog vaccination at the community level, the Federal Ministry of Agriculture and Food Security in collaboration with the Nigeria Veterinary Medical Association (NVMA) engaged twenty-four private and state veterinarians (composed of 6 teams; 4 veterinarians per team) to vaccinate dogs across the entire State (Figure 3). We conducted a cross-sectional study on data collected during the WRD celebration and the 7-day vaccination period after the flag-off of the event throughout the State. The inclusion criteria were all dogs located within Plateau State that have received antirabies vaccination and documented as such during the period of the study. There was limited bias to the study since the record of all dogs that were eligible for antirabie vaccination and vaccinated as such within the state were captured in the study.

Study population: the study population were all owned dogs eligible for antirabies vaccination (3 months and above) across Plateau State.

Data collection: information on dog ownership, demographics, and vaccination status were collected and collated over 10 days (28th September to 7th October 2024). At the University of Jos Veterinary Teaching Hospital, data was captured using an online Excel spreadsheet by the vaccinators, while the Kobocollect application was used to collect data from across all the LGAs where the vaccination exercises were conducted. The data were extracted from the Kobocollect into an Excel spreadsheet, and appropriately cleaned. Variables collected include data on State, and local government area (LGA), number of dogs per LGA, sex, breed (local, exotic, and mixed), purpose of dog keeping (pet, guard, hunting, and breeding), management system (intensive, semi-intensive and stray), number of people per household, number of dogs vaccinated per household, and geographical coordinates of the study sites. The breeds of the dogs that were administered antirabies vaccination were categorized as local, mixed and exotic breeds. The purpose of dog breeding was categorized as guard, pets, breeding, and hunting while the categorized age groups were, 6 months and below, 7 months to 3 years, and above 3 years. Challenges encountered by the vaccination team were captured. Our definition for an intensive management system of dogs is dogs that are confined within the premises and are not allowed to go outside the compound except for exercise with their owners and are solely taken care of by the owners while semi-intensive are those dogs that are fed at home by the owners, treated when they are sick but are allowed to go out of the compound and return on their own accord. Stray dogs were classified as dogs that are not owned by anyone and are constantly roaming about.

Data analysis: descriptive statistics of obtained data were performed using Microsoft Excel. Calculation of the antirabies vaccination prevalence was done using the formula [13]:

$$\text{Average number of dogs per household} = \frac{\text{Total number of antirabies vaccinated dogs}}{\text{Total number of households of antirabies vaccinated dogs}}$$

$$\text{Estimated total number of dogs in Plateau State} = \text{Average number of dogs per household} \times \text{Total number of households in Plateau State}$$

$$\%\ \text{vaccination coverage} = \frac{\text{total number of vaccinated dogs}}{\text{Total number of estimated dog population in Plateau State}}$$

Ethical clearance: the study does not require ethical clearance; data (antirabies vaccination records) from the WRD 2024 celebration were obtained officially from the office of the Chief Veterinary Officer of Nigeria (CVON), before the release by National Animal Disease Information System (NADIS).

Results

Vaccination activities: a total of 2,949 dogs were vaccinated during the WRD celebration in Plateau state. Jos North had the highest number of vaccinated dogs 570/2949(19.3%) followed by Barkin Ladi 524/2949 (17.8%) and Kanke 280/2949(9.5) LGAs (Figure 3, Figure 4). The LGA with the least number of vaccinated dogs was Jos East 37/2949 (1.3%) (Figure 3, Figure 4). Vaccination coverage for Plateau State during the exercise was 0.54% while the estimated number of dogs in the State was 542,810.

Sex of vaccinated dogs:data on sex analysis revealed that 90.5% (2667/2949) of the vaccinated dogs were categorised as either male or female. Out of which 53.1% (1416/2667) were females and 46.9% were males (1251/2667). Details on the magnitude of vaccinated male and female dogs in the various LGAs of Plateau State, as demonstrated in Figure 5.

Purpose of dog keeping: the major purpose of dog keeping in Plateau State based on the antirabies vaccination exercise was for security (guard dogs) with 71.8% (2116/2949), followed by pets, 18.1% (535/2949), breeding 5.8% (171/2949) and hunting 4.3% (127/2949) (Figure 6).

Breed types: majority were local breeds 93.3% (2750/2949), followed by mixed breeds 3.5% (102/2949), and the least were exotic breeds 3.3% (97/2949) (Figure 7).

Vaccination based on age groups: the highest percentage of vaccinated dogs is 7 months to 3 years of age with 62.1% (1831/2949), followed by those dogs that were 6 months or below, 24.5% (724/2949) and the least were those dogs that were greater than 3 years of age, 13.4% (394/2949) (Table 1).

Management system of vaccinated dogs: a total of 2932 dogs were categorised on their management system. The majority, 88.7% were under a semi-intensive management system, 10.9% (intensive management system and 0.4% were stray dogs.

Dog-household ratio and human-to-dog ratio: the ratio of the number of dogs per household was 1.5: 1 (2793/1860). The percentage of dogs that had antirabies vaccination with the number of households not captured was 5.3% (156/2949). The percentage of number of people per household data omitted was 5.4% (106 households/1966 households). The ratio of the number of humans to dogs in Plateau State was 4.6: 1 (12814 persons/2793 dogs).

Field challenges: challenges encountered by the teams during the 7-day vaccination exercise in the State were; late and limited vaccine supply on the first day, limited resources for mobility during the vaccination exercise which resulted in the use of public transport which caused unnecessary delays and inconveniences using bigger cold boxes and difficulty in movement within the allocated localities; poor mobilization for the exercise in most of the LGAs, which compelled the team to embark on house to house antirabies vaccination which was time-consuming and laborious especially using the big cold boxes that were provided for the exercise; inability to vaccinate some dogs that couldn´t be properly restrained by the owners due to the absence of dog catchers; limited time for the antirabies vaccination coverage leading to the inability of the teams to vaccinate dogs in the entire communities within LGAs, especially the rural areas.

Discussion

Unlike the previous years, this year´s WRD celebration ensured that all relevant demographic

data of antirabies vaccinated dogs were captured (using Kobocollect) during the vaccination exercise that was conducted for 7 days in Plateau State. Subsequently, vaccinated dogs demographic data will be captured in such manner for data to be made available and used efficiently as it is one of the approaches that is aimed to break rabies boundaries. Plateau State was chosen due to the high prevalence of rabies on the plateau and the vaccination was conducted in all the 17 LGAs of the State as part of enlargement of the scope of the vaccination exercise to curb the high prevalence of the disease in the State. A total of 2949 dogs were vaccinated during the WRD celebration and the 7 day antirabies vaccination exercise in Plateau State, Jos North had the highest number of dogs vaccinated. This type of antirabies vaccination should be conducted in all the States of the federation and the FCT as part of the WRD celebration annually which will result in greater coverage.

Plateau State had a vaccination coverage of 0.54% which was quite low when compared with the 70-80% WHO recommendation towards the elimination of dog-mediated-human rabies by 2030. A report from a study in Jos South LGA, Plateau State, highlighted 4.9% and 19.7% vaccination coverage from records and field surveys respectively [14]. Also, dog owners reported low vaccination coverage (26.4%) in Bauchi State [15]. A total of 13.2% (300) dogs were vaccinated out of 2,275 cases presented to the State Animal Hospital Agege, Lagos State [16]. In a nationwide study in Nigeria, vaccination data coverage was low, about 4% [17]. These findings quite differ from cross-sectional studies that usually present a much higher vaccination coverage; 64.10% [18]; 47.9% [19]; 31% of households vaccinated their dogs against rabies [20]. Perhaps, this may be due to the location where these studies were conducted, which is mostly in the urban regions. Meanwhile, a scoping review reported a vaccination rate between 15% and 38% in most states in Nigeria [6]. However, this exercise was conducted to commemorate the 2024 WRD celebration which was within a limited time frame (7 days) and we hope that with more funding from FAO-ECTAD and the FMAFS, there will be a great improvement in future celebrations of the WRD. Jos North LGA had the highest number of vaccinated dogs during the exercise, this may be because the vaccination campaign was flagged off at the LGA, which is also the State Capital. The University of Jos Veterinary Teaching Hospital as well as the State Veterinary Hospital are also located in Jos North LGA. We were able to estimate the dog population in the State (542,810) based on available data. This will aid in the process of determining the vaccination coverage in the State in the future. This data for the State was not previously available in the State. In Nasarawa state, the estimated number of dogs was 462,586 dogs [21].

The majority of the dogs vaccinated were females, this study agrees with the findings of Vakuru *et al*. [17], where the majority of the national antirabies vaccination data were females. Other studies conducted in various parts of the country had similar findings [16,18,19,21,22]. Study by Atuman *et al*. [15] in Bauchi State revealed more males (53.46%) than females (46.54%). The major purpose of dog keeping in Plateau State was for security (guard) with 71.8%. This is similar to what was obtained by Kwaghe *et al*. [21] in Nasarawa State where 77% of the vaccinated dogs were guard dogs; Akano *et al*. [22] in Osun State, 77.5% local breeds; Hambolu *et al*. [18] in Lagos State (60% of dogs were for Security); in Bauchi State revealed 69.47% for security Atuman *et al*. [15]. A scoping review from 1978 to 2020 revealed that dogs in Nigeria are mostly for security purposes (52-98%) [6]. Our study differs with the findings of Vakuru *et al*. [17], where 32.5% for hunting/guard and 27.4% as guard dogs.

Majority of the breeds vaccinated are local breeds 93.3%, followed by mixed breed 3.5% and the least were pure exotic breeds 3.3%. Similar results were obtained from various studies; 97.7% of the dogs were local breeds, 1.7% mixed and 0.3% exotic breeds [21]; 86.4% local breeds and 13.6%

exotic breeds [17]; local (57.1%), mixed (24.9%) and exotic (21%) [19]; 79.3% were local breeds [20]; local breed (62.84%), mixed breed (17.21%) and exotic breed (19.95%) [15]. Also, scoping review by Mshelbwala *et al*. [6] reveals 62-98% local dogs from dogs surveyed during ecology studies. Dogs within the age group of 7 months to 3 years were the dominant age group captured and the least were those dogs that were greater than 3 years of age, 13.4%. Our findings tallies with that of [16] where 14% of the dogs were aged above 36 months and were also the least populated based on the age categories in the study.

The management system in this study indicates that the majority of dogs are semi-intensive management system in Plateau State. This is an indication that most dogs are allowed to go out of their compound, roam around and return to the house which is also an avenue for the spread of rabies when there is no proper antirabies vaccination coverage indicating the urgency needed for a much wider vaccination coverage in the State. The ratio of the number of dogs per household is 1.5: 2 and the dog to human ratio in Plateau State is 1: 4.6. Studies in different parts of the country have the following reports; dog to household ratio was 1.1: 1 and dog to human ratio is 1.1: 6 in Nasarawa State [21]; dog to human ratio of 1: 5.6 in Lagos State [18]; an average of 2.25 dogs per household and dog-human ratio of 1: 9.95 in Kwara State [20]. The human to dog ratio of 4.1: 1 was obtained in Bauchi State and dog per household ratio 2.3: 1 [15]; dog-household ratio was 1: 1.7 in Osun State [22].

We recommend early planning of the WRD celebration and vaccination exercise since it is an annual event which will ensure the timely distribution of vaccines and consumables to teams for conduct of the vaccination exercise; provision hired or government vehicles to ease mobility for each team especially to the grassroots communities; awareness creation and sensitization in various communities that will result in mobilizing these communities for the exercise and mapping of specific point within communities should be carried out by the State veterinary staff or the District Animal Health Officers (DAHOs) of each LGA prior to the commencement of the antirabies vaccination exercise; the DAHOs should be motivated in order to yield effective results; DAHOs of each LGA should be available within their jurisdiction during vaccination exercise, to guide the team(s) deployed for vaccination; provision of adequate manpower and allocation of more days for the antirabies vaccination exercise to increase coverage and align with the zero by 30 agenda (for example, allocation of 5 days exercise for each LGA); the activity should be carried out for at least 3 consecutive years to ensure the best result; vaccine seromonitoring should be conducted for better field understanding of the seroconversion and to evaluate success targeting the 2030 rabies eradication.

Limitations to the WRD celebration in Nigeria were limited funding of the Programme by partners and the government. Limited vaccine production and availability by the NVRI which scaled down the intended number of dogs that were to be vaccinated during the period. Part of the limitation of this study is the online version of the Excel sheet that the vaccinators at the VTH Jos filled out, which did not capture the number of persons per household. Nevertheless, this exercise resulted in the accumulation of quality data which was much better than the antirabies vaccination data that were captured in the previous study Vakuru *et al*. [17] where a lot of missing data was recorded. We recommend the use of kobocollect for data capture during antirabies vaccination exercises.

Conclusion

The vaccination campaign to commemorate the celebration of the World Rabies Day 2024 in Plateau State was a good initiate by the FMAFS and FAO-ECTAD, and was carried out successfully. It is a step forward towards End Rabies by 2030

Global Alliance. The teams were able to vaccinate a total of 2949 dogs across all the 17 Local Government Areas of Plateau State, despite the poor mobilization experienced. This effort if continued will drastically reduce the cases of rabies in dogs in plateau and promote public health. We recommend that this type of WRD celebration should be done nationwide to increase rabies awareness and response of dog owners to vaccination exercises.

What is known about this topic

- *Nigeria's has 12.29% national vaccination rate as estimated by GARC;*
- *The national prevalence of antirabies vaccination from year 2020 to 2023 in Nigeria is 4.1%;*
- *Nigeria's dog population is estimated at 12,969,368.*

What this study adds

- *Plateau State had a vaccination coverage of 0.54% during the 2024 World Rabies Day celebration and an estimated dog population of 542,810;*
- *In Plateau State majority of vaccinated dogs are; security (71.8%), local breeds (93.3%), semi-intensive management system (88.7%) and age group of 7 months to 3 years (62.1%);*
- *The ratio of the number of dogs per household is 1.5: 2 and the dog to human ratio in Plateau State is 1: 4.6.*

Competing interests

The authors no competing interests.

Authors' contributions

Columba Teru Vakuru, Otto Vianney Muhinda and Ayi Vandi Kwaghe; conception of the study. Columba Teru Vakuru; data acquisition. Ayi Vandi Kwaghe; data analysis, interpretation and draft manuscript. Hamza Ibn Ibrahim; creating of study maps (data analysis). All the authors (Columba Teru Vakuru, Otto Vianney Muhinda, Kwaghe AV, Hamza Ibn Ibrahim, Patience Tomoh, David Dazhia Lazarus and Joy Gararawa Usman) read through the manuscript by revising critically the intellectual content and editing before drafting the final manuscript.

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Table and figures

Table 1: age groups and management systems of antirabies vaccinated dogs in Plateau State, Nigeria

Figure 1: map of Nigeria indicting the study area, Plateau State

Figure 2: map of Plateau State showing the LGAs where each team conducted the antirabies vaccination exercise: team 1 (blue), team 2 (purple), team 3 (white), team 4 (Orange), team 5 (grey) and team 6 (green)

Figure 3: map of Plateau State showing the dispersion of the dogs vaccinated against rabies during the 7 days mass vaccination campaign to commemorate the World Rabies Day celebration 2024

Figure 4: percentage of vaccinated dogs during the World Rabies Day and 7 day vaccination exercise in Plateau State, Nigeria

Figure 5: percentage of antirabies vaccinated based on sex in Plateau State, Nigeria

Figure 6: purpose of dog keeping in Plateau State Nigeria

Figure 7: breeds of antirabies vaccinated dogs in Plateau State, Nigeria

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Table 1: age groups and management systems of antirabies vaccinated dogs in Plateau State, Nigeria

Variables	**Categories**	**N0. vaccinated**	**% of vaccinated dogs**
Age	> 3 years	394	13.4
	7 months - 3 years	1831	62.1
	<6 months	724	24.5
	Total	2949	100.0
Management System	Intensive	319	10.9
	Semi intensive	2601	88.7
	Stray dog	12	0.4
	Total	2932	100.0

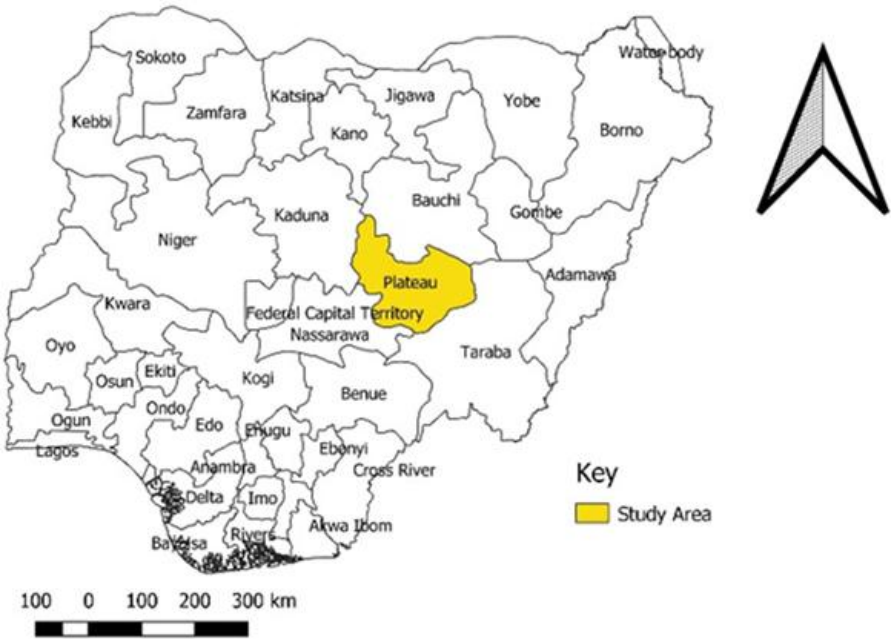

Figure 1: map of Nigeria indicting the study area, Plateau State

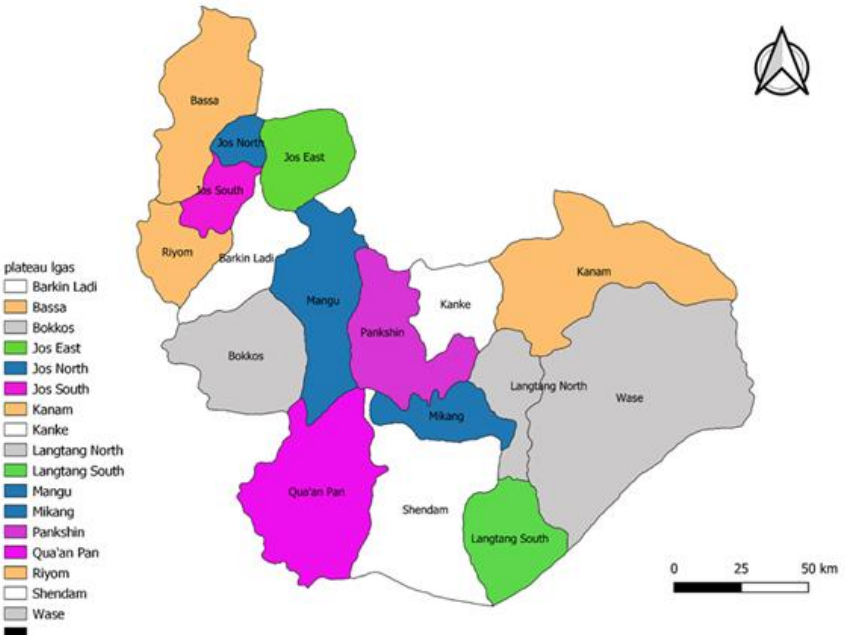

Figure 2: map of Plateau State showing the LGAs where each team conducted the antirabies vaccination exercise: team 1 (blue), team 2 (purple), team 3 (white), team 4 (Orange), team 5 (grey) and team 6 (green)

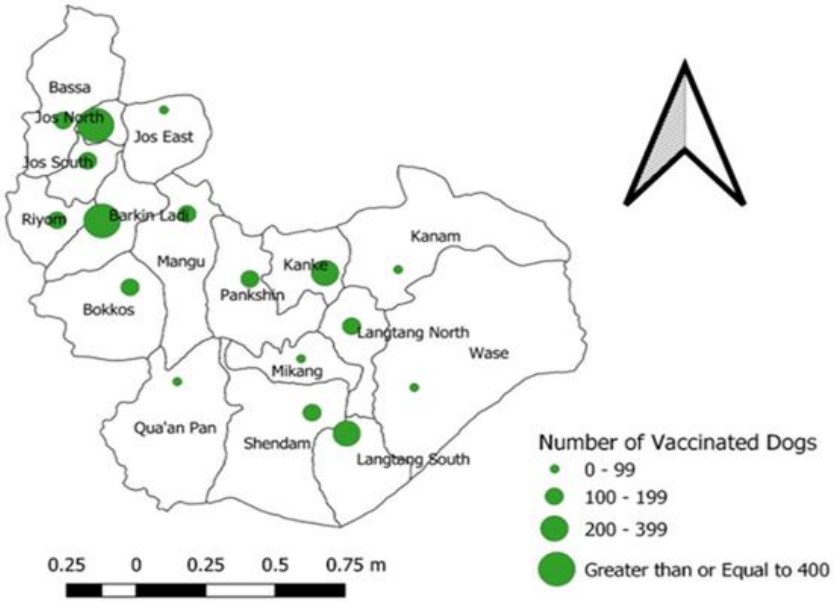

Figure 3: map of Plateau State showing the dispersion of the dogs vaccinated against rabies during the 7 days mass vaccination campaign to commemorate the World Rabies Day celebration 2024

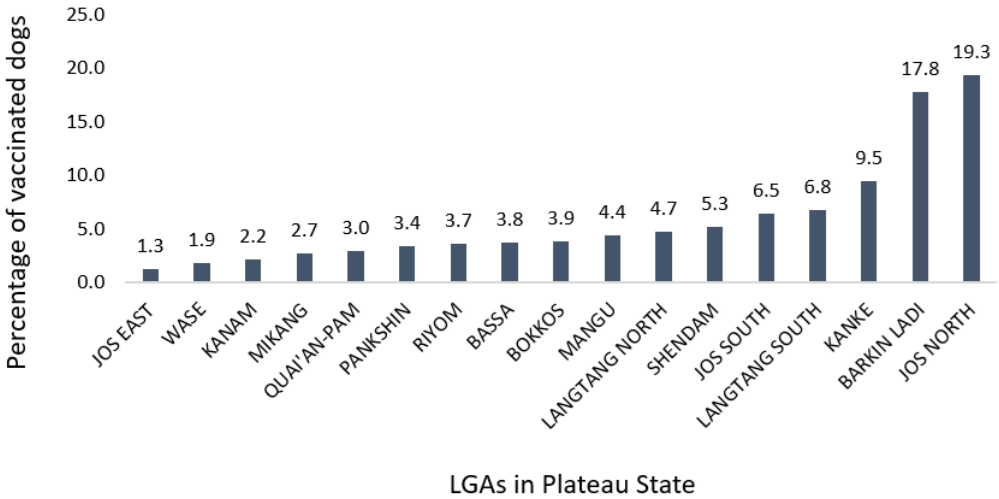

Figure 4: percentage of vaccinated dogs during the World Rabies Day and 7 day vaccination exercise in Plateau State, Nigeria

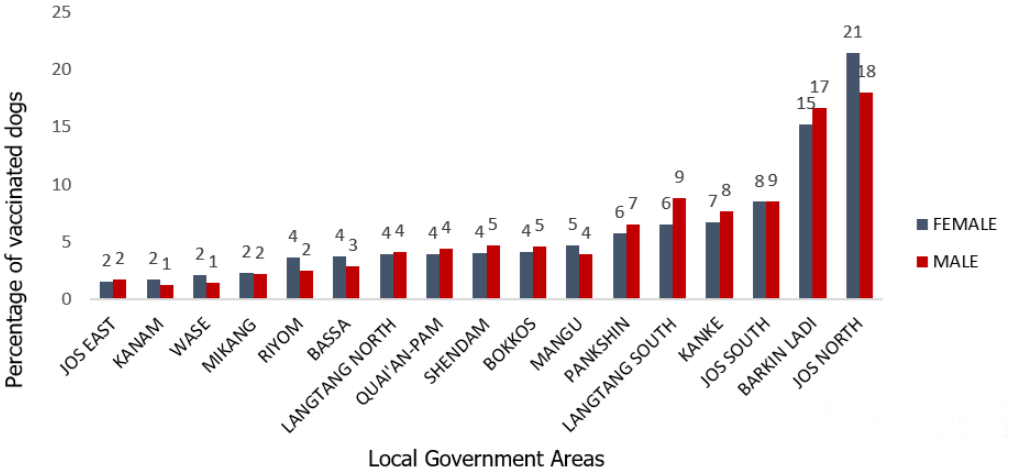

Figure 5: percentage of antirabies vaccinated based on sex in Plateau State, Nigeria

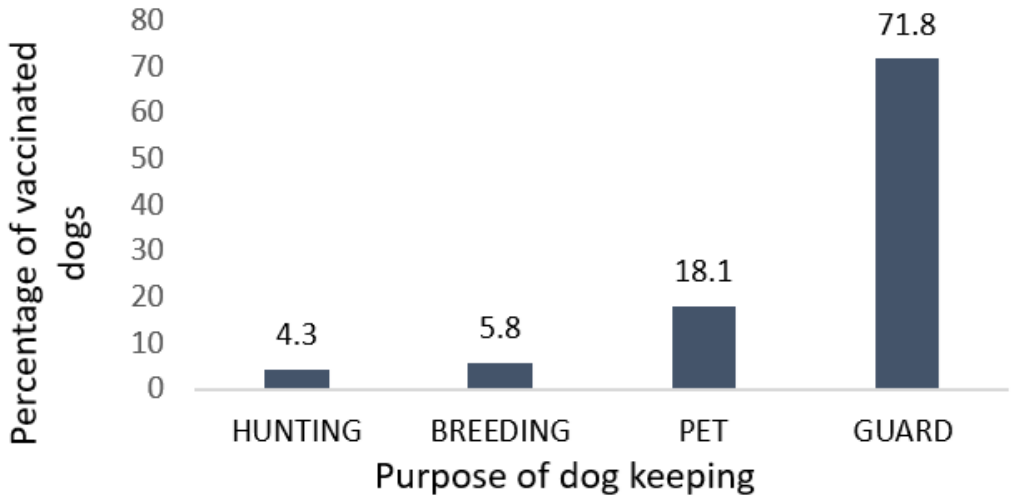

Figure 6: purpose of dog keeping in Plateau State Nigeria

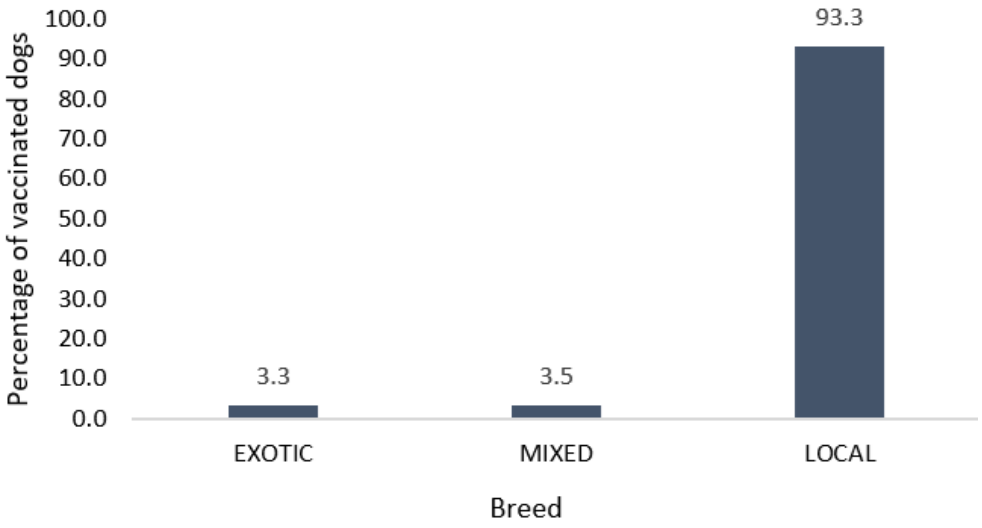

Figure 7: breeds of antirabies vaccinated dogs in Plateau State, Nigeria