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The struggle in the attempt to eliminate dog-mediated human rabies in Nigeria by 2030: a retrospective study from 2020 to 2023

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Abstract

Introduction: *dog-mediated human rabies is targeted for elimination by the year 2030. We determined the national antirabies vaccination prevalence as well as the demographic features of vaccinated dogs in Nigeria.* ***Methods:*** *we conducted a retrospective study on antirabies-vaccinated dogs in Nigeria from March 2020 to June 2023. Nationwide data of vaccinated dogs were obtained from National Animal Disease Information and Surveillance (NADIS) and extracted; State, number of dogs vaccinated, sex, breed, purpose of dog keeping, and challenges. Data obtained were collated and analysed using Microsoft Excel.* ***Results:*** *a total of 185,109 dogs were vaccinated against rabies with a national vaccination prevalence of 4.1%. Niger State had the highest number of vaccinated dogs with 14.3% (26,446). Overall, the number of identified sex of vaccinated dogs was 116,777; 63,188 (54.1%) males and 53,589 (45.9%) females. Local breeds were 86.4% while exotic breeds were 13.6%. The ratio of vaccinated exotic breeds of dogs to the local breeds was 1: 6.4. Main purpose of dog keeping identified were dogs used for hunting/guard (32.5%) and dogs kept for the guard (27.4%). Some of the challenges during the vaccination exercises were low-risk perception of the disease which led to low vaccination turnout; tearing off of vaccine labels from the vaccine vials which made it difficult or impossible to properly affix the labels to the vaccination certificate; limited logistics; some hard-to-reach areas requiring more funding and logistics for cold chain maintenance and transportation. A lot of data was missing from the data submitted to NADIS; ranging from sex, purpose of dog keeping, and breed of dog. Meanwhile, the age of vaccinated dogs was completely absent from the NADIS data.* ***Conclusion:*** *antirabies vaccination is vital for the elimination of rabies by 2030 in Nigeria. There is underreporting of antirabies vaccination in the country. We recommend standardization of vaccination forms and training of data collectors to eliminate inconsistencies in data reporting and capture necessary variables of the dog population. There is a need for continuous sensitization and awareness creation for dog owners on the need for routine antirabies vaccination of their dogs.*

Introduction

Rabies is a deadly neglected zoonotic neurological disease caused by rabies virus belonging to the genus Lyssavirus, family Rhadoviridae of the order Mononegavirales [1], affecting all warm-blooded animals and mainly transmitted through bites from rabid animals [1]. Globally, over 3 billion people reside in countries and territories where rabies exists, making them potentially exposed to the virus [2]. Over the past 30 years (1990 to 2019), there has been a significant downward trend in the global rabies age-standardized death rate (ASDR) [3]. Global rabies incidence was highest among 0-14 years in 1990 while in 2019, the 0-14 years age group and 15-49 years group had similar incidence [3]. In 2019, the region with the largest number of rabies cases was South Asia (7287.84) [3].

Globally, there are more than 15 million human exposures to rabies, mostly in Asia and sub-Saharan Africa, resulting in 3.7 million Disability-Adjusted Life Years (DALYs) and a huge economic loss of USD 8.6 billion per year [4]. The burden of rabies in Africa and Asia from endemic canine rabies, is estimated at 55,000 deaths per year [5]. In developing countries, 99% of human rabies deaths are due to bites from rabid dogs [4,6]. In Africa, studies from 1992 to 2017 revealed a total of 543,714 rabies dog bite victims, with the majority of the victims less than 15 years of age [7].

The international community called for the world to be canine rabies-free by 2030; with no indigenously acquired dog-mediated rabies cases among humans. At present, only selected countries, including Western Europe, North America, Japan, and some Latin American nations enjoy a rabies-free status [8] and in 2019, about

92 countries had near zero age-standardized incidence rate (ASIR) accounting for 45.1% of all countries [3]. Despite the global progress achieved so far, rabies remains a threat in developing nations globally.

Nigeria ranked 3rd in the global burden of disease (GBD) 2019 from 204 countries at 0.92/100,000 [3] and 2nd after India with 1295.34 deaths from rabies in 2019 [3]. In Nigeria, the prevalence of rabies in animals from 1978 to 2020 ranges from 3 to 28%, with most dog bites unprovoked (36.4%-97%) coupled with low dog vaccination rates (12-38%) [9]. Unfortunately, data on dog bite injuries and related mortality are fragmented in most developing countries [8]. The affordability and accessibility of post-exposure prophylaxis combined with risks of exposure to rabid dogs result in varying distribution of the disease burden, with a major impact on people living in poor rural communities [5].

As part of measures for the control of rabies in Nigeria, there is a need for regional collaboration regarding dog transportation, which is a major concern in the control of rabies nationwide taking into consideration the porosity of land borders surrounding the nation [9]. Emphasis should be placed on regional collaboration and cooperation with bordering countries within the West African region using cross-border joint awareness creation and sensitization, coordinated vaccination campaigns, and surveillance activities [9].

In Nigeria, only a small percentage of dog bites are officially documented in veterinary and human facilities [10,11]. Evaluation of regular vaccination by active survey is key to achieving WHO-recommended vaccination coverage. Nigeria can only align with the world rabies elimination target of 2030 set by the World Organisation for Animal Health (WOAH), the Food and Agricultural Organisation (FAO) of the United Nations, and the World Health Organisation (WHO) by active disease surveillance and enforcement of responsible dog ownership [12]. Our research questions were; (i) what is the prevalence of antirabies vaccination nationwide? (ii) what is the percentage of antirabies vaccinated male and female dogs nationwide? (iii) what are the percentages of the purpose of dog keeping in Nigeria? (iv) what is the percentage of vaccinated breeds of dogs in Nigeria? (v) are there challenges during nationwide antirabies vaccination campaigns in Nigeria? (vi) what are the gaps in the antirabies vaccination data submitted to NADIS? The objectives of the study were to determine; (i) the prevalence of antirabies vaccination nationwide for the period of study; (ii) the percentage of male and female dogs vaccinated against rabies nationwide; (iii) the percentage of the purpose of dog keeping nationwide (iv) the percentage of the breed of vaccinated dogs nationwide; (v) the challenges encountered during antirabies vaccination campaigns; and (v) identify gaps in the antirabies data submitted to NADIS as well as proffer solutions to the gaps identified.

Methods

Study area: Nigeria is located in West Africa and covers an area of 923,769 square kilometers (356,669 square meters). It is the most populous country in Africa and the world's sixth-most populous country. Nigeria borders Niger in the north, Chad in the northeast, Cameroon in the east, and Benin in the west [13]. Nigeria is a federal republic comprising 36 states and the Federal Capital Territory (FCT), where the capital, Abuja, is located [13]. Projections by the National Population Commission indicate that Nigeria constitutes a population of 216,783,381 people in 2022 [14]. Nigeria´s dog population is estimated at 4,500,000 [15].

Study design: we conducted a retrospective study on vaccinated dogs in Nigeria for a period of three years and 4 months. Nationwide data of vaccinated dogs in all 36 States and the FCT were obtained. Reports on antirabies vaccination from the year 2020 were obtained from the Regional Disease Information and Surveillance (REDISSE), Animal Health Component and compiled. Real-

time data for antirabies vaccination in Nigeria from January 2022 to March 2023 were obtained and compiled. Data from National Animal Disease Information and Surveillance (NADIS) on antirabies vaccination from January 2021 to June 2023 were extracted. The duration of the study period was from 6th August 2023 to 30th December 2023.

Study population: our study population were all dogs eligible for antirabies vaccination nationwide. Our inclusion criteria were all dogs located within Nigeria who have received antirabies vaccination and documented as such from March 2020 to June 2023.The issue of bias in this study is limited since the data collated and analysed was nationwide and all age-eligible dogs (3 months and above) vaccinated against rabies were captured during the study period analysed.

Data collection: we collated data on State, number of vaccinated dogs per state, sex, breed, purpose of dog keeping (pet, pet/guard, hunting, hunting/guard, guard, and others), and year of vaccination. Remarks from the submitted records which include challenges and recommendations captured by the vaccinators were extracted.

Data analysis: descriptive statistics of obtained data were performed using Microsoft Excel. Calculation of the antirabies vaccination prevalence was done using the formula [16]:

Quality assurance: data cleaning was done to ensure that quality data was analysed.

Ethical clearance: the study does not require ethical clearance; it was a retrospective study where secondary data (antirabies vaccination data) were analysed. The request for the release of the data was submitted to the office of the Chief Veterinary Officer of Nigeria (CVON) and approved before the release of the data by NADIS.

Results

Vaccinated dogs in Nigeria from March 2020 to June 2023: for the three years and three months duration studied (March 2020 to June 2023), Niger State had the highest number of dogs vaccinated against rabies with 26,447 (14.3%). This order is followed by Plateau 25,178 (13.6%), Taraba 19,208 (10.4%), Jigawa 13,551 (7.3%) and Adamawa 8,221 (4.4%) States (Table 1, Figure 1). Borno State had no vaccination data throughout the study and consequently the least in the study, followed by Delta, Kebbi, Sokoto and Anambara States (Table 1, Figure 1). Only three States (Bayelsa, Ekiti, and Plateau) had vaccination data throughout the study period (Table 1). In the year 2020, antirabies vaccination data report was received from 5 States (Bauchi, Bayelsa, Ekiti, Niger and Plateau) (Table 1). Plateau State had the highest vaccination data in the year 2020 with 18,339 (56.2%) of vaccinated dogs. In the years 2021 and 2022, Niger State had the highest number of vaccinated dogs with 3,600 (18%) and 18,596 (19.9%), unfortunately, there was no vaccination data for Niger State from January to June 2023 (Table 1). Year 2022 where the real-time data on antirabies vaccination of dogs were captured, had the highest number of vaccinated dogs (93, 523) (Table 1). Delta State had a vaccination record only in the year 2023 (Table 1), a total of 38,983 dogs were vaccinated against rabies in the year 2023. Furthermore, Taraba State had the highest number 10,757 (27.6%) of vaccinated dogs followed by Jigawa, 5,735 (14.7%) and Kwara, 3,661(9.4%) States. States that had no antirabies vaccination records in 2 years were; Kaduna, Kano, Kebbi, Kogi, Lagos, and Zamfara (year 2020 and 2021); Imo, Kano, and Kebbi (2020 and 2023) (Table 1). The prevalence of antirabies vaccination during the period of study was 0.7% for the year 2020, 0.4% for the year 2021, 2.1% for the year 2022, and 0.9% for the year 2023. The overall prevalence for the entire study period is 4.1%.

Percentage of vaccinated male and female dogs during the period of study: records on the sex of dogs from extracted data (year 2020), indicate female dogs 15,998 (56.3%) vaccinated were more than male dogs 12,424 (43.7%) vaccinated (Table 2). Data from real-time antirabies

vaccination of dogs (Table 3) indicates more male dogs 50,764(57.5%) compared to the vaccinated number of female dogs 37,591(42.5%) (Table 3). The overall number of identified sex of vaccinated male and female dogs is 116, 777 (Table 2, Table 3) with 63,188 males (54.1%) and 53,589 (45.9%) females.

Identified breeds of dog nationwide: only 1931 vaccinated dogs were identified by their breeds based on the extracted data (Table 4). The ratio of vaccinated exotic breed of dogs compared to the local breeds within the stipulated period is 1: 6.4, one out of every six dogs vaccinated is an exotic breed of dog. A total of, 1669 (86.4%) were local breed and the remaining 13.6% exotic (Table 4). Data reveals 1% (1931/185109) of dogs were identified with their breed.

Percentage of the purpose of dog keeping nationwide: the identified purpose of dog keeping reflects that the number of dogs used for hunting/guard was the highest, followed by strictly guard/security dogs (Table 5, Figure 2). Guard dogs 27.4% (542/1981), hunting dogs 007.1 (141/1981), hunting/guard 32.5% (643/1981), pet/companion 16.2% (320/1981) and pet/guard 16.9 (335/1981) (Table 5, Figure 2). Data obtained reflects that 1.1% (1981/185109) of antirabies vaccinated dogs were identified with the purpose of dog keeping.

Challenges during national vaccination exercises and identified gaps in the submitted vaccination data: challenges encountered on the field during the vaccination exercises were; lack of awareness of the disease; vaccinators observed that some of the vaccine labels were tearing off easily from the vaccine vials which made it difficult or impossible to properly affix the labels to the vaccination certificate; limited logistics for the exercise and some locations are hard-to-reach due to distance from towns and poor road networks requiring more funding and logistics for the cold chain maintenance and transportation; poor vaccine shortage in some locations during the exercise; limited publicity in some locations for the vaccination programme which led to low turnout for the mass vaccination campaigns at the designated veterinary clinics. Others include the need for adequate provision for the house-to-house antirabies vaccination campaign to achieve maximum success, especially in rural communities; the limited number of personnel to assist in the administration of the vaccine which made the exercise cumbersome for the vaccinators; some of the vaccination cards do not have "vaccination records" where the vaccination history of the dog is written; and the need to modify the forms so that the purpose and breed of dog should be placed on different entries, not as a single entry on the form. A lot of data was missing from the data submitted to NADIS; ranging from sex, purpose of dog keeping, and breed of dog. Meanwhile, the age of vaccinated dogs from completely absent from the NADIS data.

Discussion

The vaccination records for the period of the study indicate the need to intensify vaccination programmes in all 36 States of the federation and the FCT. At this low vaccination rate even when annual data of the highest vaccination rate was computed, the national prevalence of antirabies vaccination is at 2.1% (185,109/4,500,000). A study revealed a 4.9% prevalence of vaccinated dogs in National Veterinary Research Institute (NVRI) Vom based on sample submission from 2011 to 2016 with a 91.6% unvaccinated rate [17] while a field survey in November 2016, Jos South LGA, Plateau State, disclosed 19.7% of dog vaccination rate [17]. Similarly, a study In Nasarawa state recorded that 21% of the dogs were vaccinated and 79% had no vaccination history [18]. A report from Osun State states that 30.2% of the dogs were vaccinated, 69.8% not vaccinated [19]. A low vaccination rate is a pointer to a possible threat to animal and human health, bearing in mind that hunting dogs are a possible source of rabies introduction into their immediate communities from contact with wild reservoirs of the virus [18]. Contrary to our findings, a study in

Lagos State revealed about 64.1% of dog owners vaccinate their dogs and 57.2% of dog owners annually vaccinate their dogs against rabies [20].

This study hints at the need for effectual and efficient record keeping of vaccinated dogs in the country, which will ensure better information about the vaccinated dogs. There is a need for nationwide standardization of the antirabies vaccination data collection tool and to include all the necessary parameters that will present an adequate picture of the vaccinated dogs. This will require more awareness creation and public sensitization of dog owners as a study on knowledge, attitude and practice in Lafiya, Nasarawa State, revealed low interest of dog owners to vaccinate their dogs; only14% of people in urban and 19% in semi-urban (19%) indicated interest to vaccinate their dogs against rabies [21] which could be part of the reason Nigeria as a country is still struggling with low antirabies vaccination rate in dogs. Furthermore, in Abuja, a study indicated that the majority of respondents (58%) do not know the frequency of antirabies vaccination in dogs [22]. Also, in another study, only 47.5% were vaccinated while 52.5% were unvaccinated [23]. This further highlights the need for dog owners´ sensitization and awareness of the relevance of annual dog vaccination against rabies to meet the WHO target of eliminating dog-mediated human rabies by the year 2030.

Minimal data was collected in terms of the breed of dogs and the purpose of dog keeping; data obtained shows that 1.1% of vaccinated dogs were identified with their breed and purpose of dog keeping. Some ecological studies tallied with our findings where the majority of the dogs surveyed were Indigenous (62-98%) [9]; a study conducted in Nasarawa state indicated 97.7% of the dogs were local breeds, 1.7% mixed and 0.3% exotic breeds [18]. Furthermore, other studies indicated similar results; Kaduna State had a local breed of 72.5%, exotic 8.8%, crossbreed of 18.7% [24]; Niger State had 60.1% of the dogs were local breed of 60.1%, 25.4% exotic and 14.5% mixed breed [25]; Kwara State79.3 % (n = 523/659) of the owned dogs were local breeds [26]. Other studies that differed from our findings are; Lagos State with 41.9% local, 29.5% exotic, and 28.6% cross-breeds [20]; Umahia with 57.1% local breed, 24.9% cross-breed and 21% exotic breed [23]; Abia state had 19% local, 66.3% exotic, 14.7% cross-breed [27].

Regarding the purpose of dog keeping in Nigeria, most of the dogs are used for dual purpose (hunting/guarding), followed by dogs that were only used as guard dogs. Since the majority of the vaccinated dogs are local breeds, this might probably reflect their use as hunting and guard dogs, which is a common practice in the rural communities of the country. Similarly, in Nasarawa state, Nigeria, guard dogs were 77% and 23% were used for hunting [18]. Other studies also reflect similar reports; guard 63.5%, sale/breeding 24.4% and pet 12.2% [27]; security(guard) 58.6%, pet 8.6%, hunting 17.1%, breeding 15%, herding 0.7% [25]; guard 85.2%, pet 8.9%, guard/hunting 4%, hunting 2% [24]; 60% of dogs are used for security, 26% as pet, 8% breeding, 1% hunting, 2% security/pet, 2% security/breeding, 1% security/breeding/pet [20].

Challenges encountered on the field during the vaccination exercises were limited/lack of awareness of the disease resulting in low-risk perception; vaccine labels were torn off from the vaccine vials which made it difficult or impossible to properly affix the labels to the vaccination certificate; limited logistics for the exercise and some locations are hard-to-reach (very rural) areas that require more funding and logistics for the cold chain maintenance and transportation; vaccine shortage in some locations during the exercise; limited publicity in some locations for the vaccination programme which led to low turnout for the mass vaccination were also reported by Nyasulu *et al*. [7].

To counter some of the field challenges we recommended that vaccines should be placed in waterproof parcels before storing them in the fridges to avoid damage to the seal so that they

can be detached and attached to the pet book after vaccination; intensification of house-to-house antirabies vaccination of dogs; continuous mass vaccination campaigns; training more vaccinators for the annual antirabies vaccination exercise; standardization of the antirabies vaccination cards for it to capture the required variables such as the vaccination history and standardization of the data collection tool nationwide that will incorporate all the variables that are essential to enhance the demographic picture of the vaccinated dogs.

Antirabies vaccination data collected so far has shown that limited data is being remitted at the Federal level (NADIS) and based on the total estimated number of dogs in the country, which is about 4.5 million [15], the study has proved that Nigeria is far from establishing the 70-80% vaccination rate in the country towards the elimination dog-mediated human rabies by 2030 as stipulated [12]. Some of the limitations of the study were due to the fact that secondary data was used for the study. Data collection has not been consistent and there seems to be minimal data for the ongoing antirabies annual vaccination campaigns from March 2020 to June 2023. During the data analysis, some inconsistencies with data collection were noticed. In 2020, the antirabies data report was sent from the field to NADIS in the form of summary reports. While from 2021 to 2023, data was obtained from NADIS. In 2022 to March 2023, antirabies vaccination data was captured in real-time (variables such as States, local government areas (LGAs), communities, number of dogs vaccinated, and sex were all captured) with all other necessary information while the rest of the data had no record of basic information such as the sex, breed and purpose of dog keeping. These circumstances brought about complexities in data analysis as we analysed the variables available, which led to the varying number of antirabies vaccinated dogs depending on the variable that was analysed. The only complete variable was the number of dogs vaccinated.

To the best of our knowledge, this is the first attempt to analyze national antirabies vaccination data in Nigeria. The antirabies vaccination data is generalizable since it was obtained nationwide, but other data on breed and purpose of dog breeding which is just about 1% of the vaccinated dogs may not be generalizable as about 99% of data was missing. Nevertheless, it can still serve as baseline data since there is no nationwide data analysed in relation to this. This study was aimed at determining the national antirabies vaccination prevalence as well as the demographic features of vaccinated dogs in Nigeria which was achieved despite some of the data deficiencies (missing data). This study is a wake-up call for Nigeria to brace up in trying to eliminate dog-mediated human rabies by the year 2030 and shows the need for standardization of the data collection tool.

Conclusion

The total number of dogs vaccinated against rabies was 185,109. The result indicates that the prevalence of antirabies vaccination in dogs compared with the dog population in the country is low (4.1%). There is a need to intensify reporting of antirabies vaccination in all the 36 States of the Federation and the FCT; standardize the reporting format of the vaccination exercise to avoid the problem of missing data; organize awareness campaigns for the promotion of the antirabies vaccination; proper funding of the exercise in the hard-to-reach communities especially during house-to-house vaccination.

What is known about this topic

- *Dog-mediated-human rabies is targeted for elimination by the year 2030 globally;*
- *Ninety-nine percent of human rabies deaths are due to bites from rabid dogs;*
- *Rabies is endemic in Nigeria.*

What this study adds

- *The national prevalence of antirabies vaccination for the period under study is 4.1%;*
- *National data reveals 54.1% of antirabies vaccinated dogs were males and 45.9% females;*
- *Local breed of dogs vaccinated against rabies constitutes 86.4% while exotic breeds were 13.6% and the ratio of a vaccinated exotic breed of dogs to the local breeds was 1: 6.*

Competing interests

The authors declare no competing interests.

Authors' contributions

Vakuru CT: conception of the study and data acquisition. Kwaghe AV: data analysis, interpretation, and draft manuscript. Authors read through the manuscript by revising critically for important intellectual content before drafting the final manuscript.

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Tables and figures

Table 1: vaccinated dogs (n=185,109) in Nigeria (36 states plus federal capital territory (FCT) from March 2020 to June 2023

Table 2: antirabies vaccination of male and female dogs (n=28,422) year 2020 in Nigeria

Table 3: real-time capture of antirabies vaccination of dogs in Nigeria from January 2022, to March 2023, n=88, 355 based on sex

Table 4: real-time capture of breeds of dogs vaccinated against rabies in Nigeria from January 2022 to March 2023, n=1931

Table 5: vaccinated dogs in Nigeria based on the purpose of dog keeping Jan 2022 to March 2023 based on real-time capture of the mass vaccination program

Figure 1: percentage of the total number of vaccinated dogs (n=185,109) from March 2020 to June 2023 in the 36 states and the federal capital territory (FCT) in Nigeria

Figure 2: real-time captured the purpose of dog keeping (n=1,981) in Nigeria from Jan

2022 to March 2023 during the mass antirabies vaccination programme

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Table 1: vaccinated dogs (n=185,109) in Nigeria (36 states plus FCT) from March 2020 to June 2023						
S/N0	**States**	**The year 2020 (% vaccinated dogs)**	**The year 2021 (% vaccinated dogs)**	**The year 2022 (% vaccinated dogs)**	**The year 2023 (% vaccinated dogs)**	**Total (% vaccinated dogs)**
1	Abia	0 (0.0)	254 (1.3)	2703 (2.9)	168 (0.4)	3129 (1.7)
2	Adamawa	0 (0.0)	3119 (15.6)	3644 (3.9)	1438 (3.7)	8221 (4.4)
3	Akwa Ibom	0 (0.0)	2 (0.0)	2944 (3.1)	1604 (4.1)	4553 (2.5)
4	Anambra	0 (0.0)	70 (0.4)	290 (0.3)	242 (0.6)	603 (0.3)
5	Bauchi	2600 (8.0)	0 (0.0)	3532 (3.8)	412 (1.1)	6556 (3.5)
6	Bayelsa	2483 (7.6)	529 (2.6)	975 (1.0)	1229 (3.2)	5227 (2.8)
7	Benue	0 (0.0)	75 (0.4)	5911 (6.3)	686 (1.8)	6679 (3.6)
8	Borno	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
9	Cross River	0 (0.0)	57 (0.3)	3687 (3.9)	202 (0.5)	3950 (2.1)
10	Delta	0 (0.0)	0 (0.0)	0 (0.0)	94 (0.2)	94 (0.1)
11	Ebonyi	0 (0.0)	255 (1.3)	1396 (1.5)	409 (1.0)	2063 (1.1)
12	Edo	0 (0.0)	728 (3.6)	1178 (1.3)	514 (1.3)	2425 (1.3)
13	Ekiti	5000 (15.3)	502 (2.5)	1246 (1.3)	1346 (3.5)	8113 (4.4)
14	Enugu	0 (0.0)	146 (0.7)	1297 (1.4)	202 (0.5)	1647 (0.9)
15	Federal Capital Territory	0 (0.0)	127 (0.6)	1892 (2.0)	1784 (4.6)	3806 (2.1)
16	Gombe	0 (0.0)	624 (3.1)	3862 (4.1)	1891 (4.9)	6384 (3.4)
17	Imo	0 (0.0)	223 (1.1)	749 (0.8)	0 (0.0)	974 (0.5)
18	Jigawa	0 (0.0)	2956 (14.8)	4840 (5.2)	5735 (14.7)	13551 (7.3)
19	Kaduna	0 (0.0)	0 (0.0)	4043 (4.3)	273 (0.7)	4320 (2.3)
20	Kano	0 (0.0)	133 (0.7)	633 (0.7)	0 (0.0)	767 (0.4)
21	Katsina	0 (0.0)	1076 (5.4)	656 (0.7)	149 (0.4)	1887 (1.0)
22	Kebbi	0 (0.0)	255 (1.3)	1 (0.0)	0 (0.0)	257 (0.1)
23	Kogi	0 (0.0)	0 (0.0)	464 (0.5)	213 (0.5)	677 (0.4)
24	Kwara	0 (0.0)	13 (0.1)	1660 (1.8)	3661 (9.4)	5336 (2.9)
25	Lagos	0 (0.0)	0 (0.0)	1487 (1.6)	429 (1.1)	1918 (1.0)
26	Nasarawa	0 (0.0)	15 (0.1)	2900 (3.1)	47 (0.1)	2965 (1.6)
27	Niger	4200 (12.9)	3600 (18.0)	18596 (19.9)	0 (0.0)	26447 (14.3)
28	Ogun	0 (0.0)	93 (0.5)	412 (0.4)	138 (0.4)	644 (0.3)
29	Ondo	0 (0.0)	65 (0.3)	3300 (3.5)	137 (0.4)	3506 (1.9)
30	Osun	0 (0.0)	226 (1.1)	2031 (2.2)	779 (2.0)	3039 (1.6)
31	Oyo	0 (0.0)	122 (0.6)	1328 (1.4)	356 (0.9)	1808 (1.0)
32	Plateau	18339 (56.2)	1456 (7.3)	4556 (4.9)	759 (1.9)	25178 (13.6)
33	Rivers	0 (0.0)	364 (1.8)	548 (0.6)	181 (0.5)	1095 (0.6)
34	Sokoto	0 (0.0)	88 (0.4)	146 (0.2)	106 (0.3)	341 (0.2)
35	Taraba	0 (0.0)	1908 (9.5)	6526 (7.0)	10757 (27.6)	19208 (10.4)
36	Yobe	0 (0.0)	900 (4.5)	2072 (2.2)	2491 (6.4)	5470 (3.0)
37	Zamfara	0 (0.0)	0 (0.0)	2018 (2.2)	551 (1.4)	2571 (1.4)
Grand total		32622 (100.0)	19981 (100.0)	93523 (100.0)	38983 (100.0)	185109 (100.0)

Table 2: antirabies vaccination of male and female dogs (n=28,422) year 2020 in Nigeria			
States	**% Vaccinated male dogs**	**% Vaccinated female dogs**	**% Total N0. of vaccinated dogs**
Bayelsa	1090 (8.8)	1393 (8.7)	2483 (8.7)
Ekiti	1542 (12.4)	3,458 (21.6)	5,000 (17.6)
Plateau	8069 (64.9)	10270 (64.2)	18339 (64.5)
Bauchi	1723 (13.9)	877 (5.5)	2600 (9.1)
Grand total	12424 (100.0)	15998 (100.0)	28422 (100.0)

Table 3: real-time capture of antirabies vaccination of dogs in Nigeria from January 2022, to March 2023, n=88, 355 based on sex			
States	**% Vaccinated male dogs**	**% Vaccinated female dogs**	**% Total N0. of vaccinated dogs**
Abia	598 (1.2)	558 (1.5)	1156 (1.3)
Akwa Ibom	69 (0.1)	164 (0.4)	233 (0.3)
Bauchi	2224 (4.4)	1691 (4.5)	3915 (4.4)
Bayelsa	359 (0.7)	274 (0.7)	633 (0.7)
Benue	3292 (6.5)	1908 (5.1)	5200 (5.9)
Cross River	1955 (3.9)	1895 (5.0)	3850 (4.4)
Ebonyi	122 (0.2)	292 (0.8)	414 (0.5)
Edo	196 (0.4)	270 (0.7)	466 (0.5)
Ekiti	90 (0.2)	115 (0.3)	205 (0.2)
Gombe	6809 (13.4)	3463 (9.2)	10272 (11.6)
Jigawa	734 (1.4)	453 (1.2)	1187 (1.3)
Kaduna	2398 (4.7)	1555 (4.1)	3953 (4.5)
Kogi	22 (0.0)	23 (0.1)	45 (0.1)
Kwara	876 (1.7)	695 (1.8)	1571 (1.8)
Lagos	756 (1.5)	732 (1.9)	1488 (1.7)
Nasarawa	1448 (2.9)	1464 (3.9)	2912 (3.3)
Niger	9473 (18.7)	8131 (21.6)	17604 (19.9)
Ogun	126 (0.2)	187 (0.5)	313 (0.4)
Ondo	1873 (3.7)	1557 (4.1)	3430 (3.9)
Osun	176 (0.3)	179 (0.5)	355 (0.4)
Oyo	25 (0.0)	23 (0.1)	48 (0.1)
Plateau	1736 (3.4)	2355 (6.3)	4091 (4.6)
Rivers	304 (0.6)	244 (0.6)	548 (0.6)
Taraba	13122 (25.8)	8710 (23.2)	21832 (24.7)
Yobe	1579 (3.1)	493 (1.3)	2072 (2.3)
Zamfara	402 (0.8)	160 (0.4)	562 (0.6)
Grand total	50764 (100.0)	37591 (100.0)	88355 (100.0)

Table 4: real-time capture of breeds of dogs vaccinated against rabies in Nigeria from January 2022 to March 2023, n=1931

States	% Exotic Breeds	% Local Breeds	% Total
Akwa Ibom	1 (100.0)	0(0.0)	1 (100.0)
Oyo	1 (100.0)	0 (0.0)	1 (100.0)
Kogi	1 (25.0)	3 (75.0)	4 (100.0)
Rivers	3 (60.0)	2 (40.0)	5 (100.0)
Edo	5 (27.8)	13 (72.2)	18 (100.0)
Ebonyi	2 (15.4)	11 (84.6)	13 (100.0)
Ekiti	6 (46.2)	7 (53.8)	13 (100.0)
Lagos	11 (84.6)	2 (15.4)	13 (100.0)
Yobe	0 (0.0)	18 (100.0)	18 (100.0)
Benue	0 (0.0)	19 (100.0)	19 (100.0)
Bayelsa	10 (40.0)	15 (60.0)	25 (100.0)
Osun	6 (23.1)	20 (76.9)	26 (100.0)
Ogun	19 (65.5)	10 (34.5)	29 (100.0)
Jigawa	1 (3.2)	30 (96.8)	31 (100.0)
Niger	4 (9.3)	39 (90.7)	43 (100.0)
Cross River	3 (5.9)	48 (94.1)	51 (100.0)
Ondo	34 (58.6)	24 (41.4)	58 (100.0)
Abia	38 (46.9)	43 (53.1)	81 (100.0)
Kwara	13 (15.1)	73 (84.9)	86 (100.0)
Taraba	1 (0.9)	109 (99.1)	110 (100.0)
Plateau	0 (0.0)	125 (100.0)	125 (100.0)
Kaduna	13 (9.6)	122 (90.4)	135 (100.0)
Bauchi	0 (0.0)	161 (100.0)	161 (100.0)
Gombe	5 (1.9)	259 (98.1)	264 (100.0)
Zamfara	39 (14.0)	240 (86.0)	279 (100.0)
Nasarawa	46 (14.3)	276 (85.7)	322 (100.0)
Grand total	262 (13.6)	1669 (86.4)	1931 (100.0)

Table 5: vaccinated dogs in Nigeria based on the purpose of dog keeping Jan 2022 to March 2023 based on real-time capture of the mass vaccination program

State	Purpose of dog keeping					% Total
	% Guard (security)	% Hunting	% Hunting/Guard	% Pet/companion	% Pet/Guard	
Abia	26 (32.1)	1 (1.2)	14 (17.3)	7 (8.6)	33 (40.7)	81 (100.0)
Akwa Ibom	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	1 (100.0)
Bauchi	0 (0.0)	0 (0.0)	139 (86.3)	4 (2.5)	18 (11.2)	161 (100.0)
Bayelsa	5 (20.0)	0 (0.0)	10 (40.0)	2 (8.0)	8 (32.0)	25 (100.0)
Benue	0 (0.0)	0 (0.0)	18 (90.0)	0 (0.0)	2 (10.0)	20 (100.0)
Cross River	13 (25.0)	1 (1.9)	15 (28.8)	19 (36.5)	4 (7.7)	52 (100.0)
Ebonyi	1 (7.7)	0 (0.0)	10 (76.9)	0 (0.0)	2 (15.4)	13 (100.0)
Edo	3 (16.7)	3 (16.7)	4 (22.2)	3 (16.7)	5 (27.8)	18 (100.0)
Ekiti	0 (0.0)	0 (0.0)	0 (0.0)	13 (100.0)	0 (0.0)	13 (100.0)
Gombe	57 (21.3)	7 (2.6)	185 (69.3)	10 (3.7)	8 (3.0)	267 (100.0)
Jigawa	5 (16.1)	0 (0.0)	25 (80.6)	1(3.2)	0 (0.0)	31 (100.0)
Kaduna	23 (14.7)	13 (8.3)	60 (38.5)	20 (12.8)	40 (25.6)	156 (100.0)
Kogi	0 (0.0)	0 (0.0)	1 (25.0)	3 (75.0)	0 (0.0)	4 (100.0)
Kwara	20 (22.7)	9 (10.2)	34 (38.6)	21 (23.9)	4 (4.5)	88 (100.0)
Lagos	0 (0.0)	0 (0.0)	0 (0.0)	6 (46.2)	7 (53.8)	13 (100.0)
Nasarawa	94 (29.0)	36 (11.1)	22 (6.8)	142 (43.8)	30 (9.3)	324 (100.0)
Niger	10 (23.3)	0 (0.0)	23 (53.5)	3 (7.0)	7 (16.3)	43 (100.0)
Ogun	9 (31.0)	0 (0.0)	2 (6.9)	8 (27.6)	10 (34.5)	29 (100.0)
Ondo	29 (49.2)	5 (8.5)	4 (6.8)	12 (20.3)	9 (15.3)	59 (100.0)
Osun	11 (40.7)	0 (0.0)	3 (11.1)	11 (40.7)	2 (7.4)	27 (100.0)
Oyo	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 100.0)	1 (100.0)
Plateau	0 (0.0)	0 (0.0)	0 (0.0)	5 (4.0)	121 (96.0)	126 (100.0)
Rivers	0 (0.0)	1 (20.0)	3 (60.0)	1 (20.0)	0 (0.0)	5 (100.0)
Taraba	56 (50.9)	1 (0.9)	35 (31.8)	10 (9.1)	8 (7.3)	110 (100.0)
Yobe	0 (0.0)	3 (16.7)	15 (83.3)	0 (0.0)	0 (0.0)	18 (100.0)
Zamfara	180 (60.8)	61 (20.6)	2 (7.1)	18 (6.1)	16 (5.4)	296 (100.0)
Grand Total	542 (27.4)	141 (7.1)	643(32.5)	320 (16.2)	335 (16.9)	1981 (100.0)

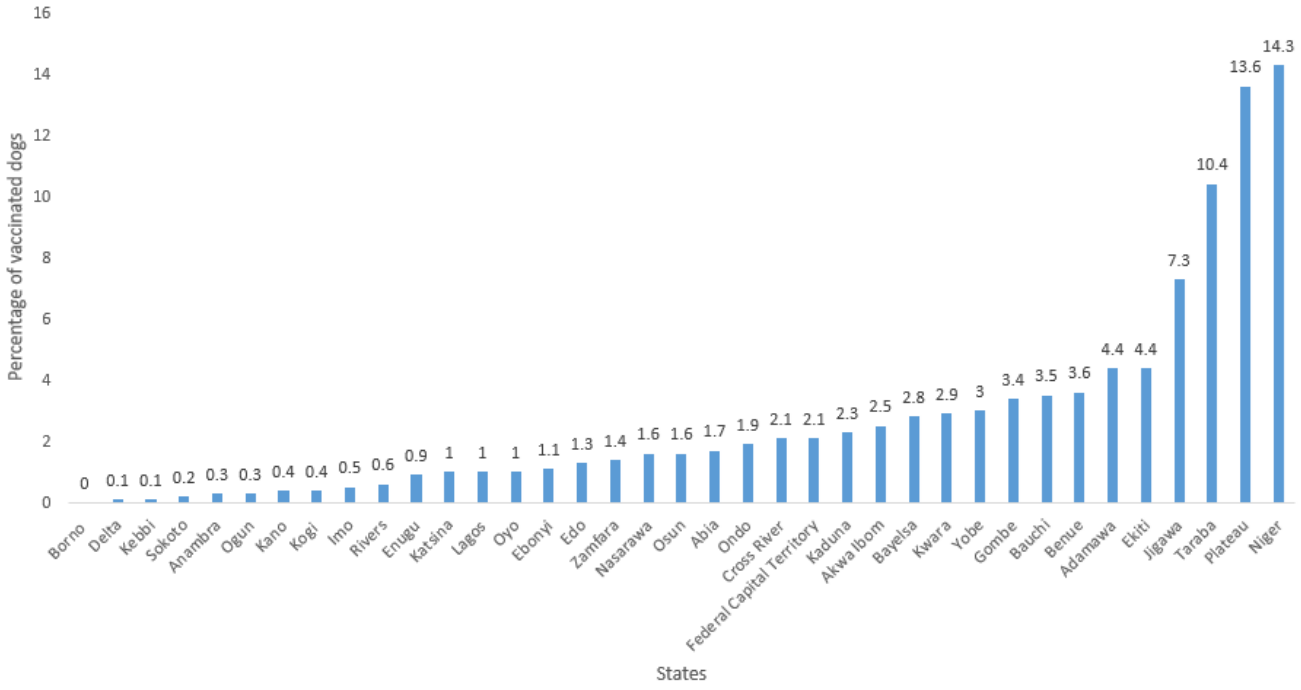

Figure 1: percentage of the total number of vaccinated dogs (n=185,109) from March 2020 to June 2023 in the 36 states and the federal capital territory (FCT) in Nigeria

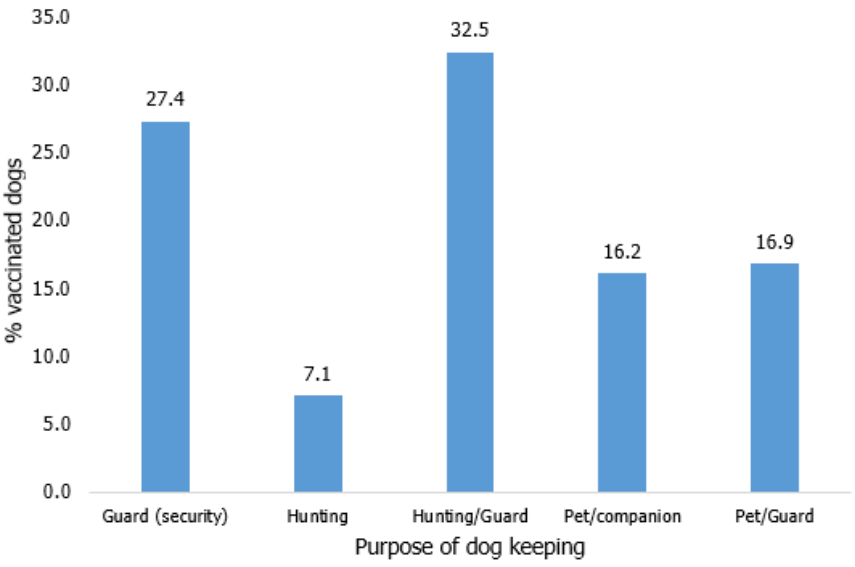

Figure 2: real time captured the purpose of dog keeping (n=1,981) in Nigeria from Jan 2022 to March 2023 during the mass antirabies vaccination programme