



## Research Article

# Rabies pre-exposure vaccination of occupationally high-risk individuals in Nigeria

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## ABSTRACT

Rabies is a highly deadly viral disease that affects the central nervous system and is transmitted from animals to humans. This study focuses on assessing rabies vaccination status among occupationally exposed humans in Nigeria and identifies strategies to improve vaccination coverage and strengthen rabies prevention efforts in these vulnerable occupations. Nigeria, being the most populous country in Africa, is heavily burdened by rabies. Occupationally exposed persons, such as veterinarians, animal control personnel and handlers, are at risk rabies exposure due to regular interactions with potentially infected animals. A cross-sectional survey was conducted using a self-structured questionnaire which was administered online using google form with 275 respondents. The study targets a variety of occupational groups at higher risk of exposure to rabies, collecting data on variables such as gender, age, occupation, vaccination history, vaccination source, health insurance coverage and willingness to receive free rabies vaccination. Results showed that 54.2 % of the respondents were administered with pre-exposure rabies vaccine. Age and occupation showed significant ( $p < 0.05$ ) associations with the vaccination status. Assessment of the rabies vaccine status among occupationally exposed persons in Nigeria provides useful insights into the current rabies prevention situation and highlights areas for improvement. Finally, this research contributes to the creation of a safer working environment and to improving the results of public health in the country.

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## INTRODUCTION

Rabies is a highly lethal viral disease that affects the central nervous system and is transmitted from animals to humans (WHO, 2023). Rabies is an infectious disease that occurs in more than 150 countries and territories and has a higher risk of infection in Asia and Africa (Hampson *et al.*, 2019). The World Health Organization (WHO, 2018) detailed that the disease kills tens of thousands of individuals every year (WHO, 2019). Every year, there are about 600,000 fatal cases of rabies worldwide, of which almost 99 per cent occur in Africa and Asia (WHO, 2018). In Africa, human rabies continues to be a significant public health problem, with epidemics reported in most countries. Nigeria, the most populous country on the continent, bears a significant burden on public health due to rabies. This burden is partly due to the ongoing challenges of implementing a comprehensive national programme for the prevention and control of rabies (Mshelbwala *et al.*, 2021). Rabies is mainly transmitted by bites or scratches on animals infected with viruses. It is important to note that the virus can also be transmitted if infected saliva enters an open wound or comes into contact with mucous membranes such as mouth, nose or eyes, which goes beyond simple bites (CDC, 2022). In terms of human infections, dogs serve as the primary reservoir and source of transmission (CDC, 2019). Other animals such as raccoons, skunks, bats, and foxes are commonly known carriers of the rabies virus (CDC, 2022).

Occupational groups such as veterinarians, animal control personnel, animal handlers, laboratory personnel, wildlife officials and medical providers specializing in the treatment of animal bites face a higher probability of being exposed to rabies. This increased risk stems from their regular interaction with animals, as these individuals often meet potentially rabid animals, thereby increasing their susceptibility to disease (Mshelbwala *et al.*, 2021).

Vaccination against rabies is a crucial preventive measure to protect individuals at risk of exposure (WHO, 2018). The rabies vaccine exhibits high efficacy in preventing the manifestation of the disease when administered promptly following exposure. Moreover, pre-exposure vaccination confers a foundational level of immunity, mitigating the severity of the disease upon subsequent exposure (Mshelbwala *et al.*, 2021). The necessity of acquiring vaccinations, particularly pre-exposure rabies vaccination, becomes increasingly crucial in regions endemic to the disease, aligning with the recommendations put forth by the Advisory Committee on Immunization Practices (ACIP) (Shi *et al.*, 2020). Several rabies vaccines have been developed, including the Human Diploid Cell (HDCV) and the Purified Chicken Embryo Cell (PCEC), but these vaccines are not without side effects. Commercial human rabies immune Globin (HRIG) was also used for prophylactic treatment and was recommended as part of post-exposure rabies vaccination (CDC, 2014). There is an indication that undergoing a regimen of pre-exposure rabies vaccinations could facilitate the administration of post-exposure vaccination in a more streamlined and economically efficient manner for individuals who have already received the pre-exposure vaccination. Moreover, this pre-exposure vaccination affords protection against potential exposure to the rabies virus that could potentially be overlooked or undetected (Daodu *et al.*, 2017).

Consequently, conducting an assessment of the rabies vaccination status among occupationally exposed individuals is imperative for appraising their level of safeguarding and pinpointing any deficiencies in vaccination coverage. Occupations involving direct interaction with animals entail a heightened inherent susceptibility to zoonotic diseases, thereby exposing individuals to a greater risk of acquiring diseases transmitted from animals to humans. Studies show that between 35 % and 64 % of

veterinarians have reported contracting a zoonotic infection at some point during their professional career (Blanton *et al.*, 2018). This study seeks to assess the current status of rabies vaccination among occupationally exposed individuals in Nigeria. A thorough understanding of the coverage of vaccination is expected to provide strategies for improving vaccination rates, promoting awareness and strengthening efforts to prevent rabies in these vulnerable occupations. The results of this assessment will contribute to a comprehensive understanding of the current landscape related to rabies prevention among individuals exposed to the work in Nigeria and guide future interventions to mitigate the burden of rabies. Through this research, we hope to increase our understanding of the status of rabies vaccination among individuals at high risk of exposure, eventually striving for a safer working environment and improved results in public health in Nigeria.

## Materials and Methods

### Study Design

A cross-sectional survey was conducted in Nigeria (August 2022 to May 2023), to collect comprehensive data on the status of rabies vaccination and associated factors among occupationally exposed individuals. The study focused on several occupational groups with higher risk of rabies exposure, including veterinarians, animal control personnel, animal handlers, laboratory personnel, wildlife officials and health professionals involved in animal bite management. A convenient sampling was used to recruit participants from all Nigerian states. A minimum sample size of 250 was expected to give the study significant results and power of 80%. Three hundred respondents returned their completed questionnaires and 25 were rejected due to incomplete information supplied making them invalid for analysis. The instrument was a self-administered questionnaire. It consists of 15 close-ended questions and was divided into three questions sections: Socio-demography, history of rabies vaccination and risk factors.

### Inclusion and Exclusion Criteria

**Inclusion:** Individuals directly exposed at their workplace and are involved in the treatment of animals (dogs and domestic cats as well as wildlife) who have informed consent.

**Exclusion:** Individuals not directly exposed at their workplace and are not involved in the treatment of animals (dogs and domestic cats as well as wildlife).

### Questionnaire Administration

The collection of data included a structured questionnaire, which was administered via Google forms, dealing with various aspects such as gender, age, occupation, practice or school status, affiliation, pre-exposure vaccine history, year of vaccination, source of vaccination, health insurance cover, and willingness to receive free rabies vaccinations. The link was shared to various groups of the target audience.

### Data Analysis

Data were presented in tables and analysed using Statistical Package for Social Sciences (SPSS, Version 25). Descriptive statistics, such as frequencies and percentages, were calculated to summarize the distribution of variables and responses. Chi-square test for association was conducted to assess the association between variables and the pre-exposure vaccination status. Additionally, multivariate analysis was performed to determine the odds ratios and confidence intervals associated with the selected variables. Values of  $p < 0.05$  were considered as significant.

## RESULT

### Distribution of Variables and Responses

A total of 275 responses were collected through the utilization of a web-based survey. The estimated distribution of the survey was approximately 512 individuals, resulting in an estimated response rate of 54 % (275/512). Among the 275 respondents, 200 (72.7%) identified as veterinarians, 13 (4.7 %) Para-veterinarians, 51 (18.5 %) veterinary clinical students, 3 (1.1%) dog breeders, 1 (0.4%) zoo keeper, and 7 (2.5 %) identified as belonging to other occupational categories (Table 1). Within the participant pool of 275 individuals,

192 (69.8 %) were male, 81 (29.5 %) were female, and 2 (0.7 %) preferred not to disclose their gender. Regarding the age distribution of participants, the findings indicated that 39 (14.2 %) fell within the 18 - 25 years age group, 198 (72.0 %) belonged to 26 - 35 years age group, 24 (8.7 %) were in the 36 - 45 years age group, and 14 (5.1 %) were aged 46 years or above (Table 1).

It was observed that out of the 275 participants, 87 (31.6 %) possessed health insurance, while the remaining 188 (68.4 %) did not have such coverage. Regarding rabies pre-exposure vaccination, 149 (54.2 %) individuals had received it, while 126 (45.8 %) had not. Among the 149 respondents who had received the pre-exposure vaccination, 16 (10.7 %) were vaccinated by their employers, 8 (5.4 %) received vaccination through a non-governmental organization (NGO), 30 (20.1 %) opted for personal vaccination, and 95 (63.8 %) were vaccinated during their school period. For Occupation, 200 (72.7 %) were Veterinarians, 13 (4.7 %) were para-veterinarians, 51 (18.5 %) Veterinary clinical student, 3 (1.1 %) dog breeders, 1 (0.4) zoo keepers, and 7 (2.5 %) others (Table 1).

#### **Univariate and multivariate analysis showing the association between pre-exposure vaccination and various variables**

In terms of gender, the univariate analysis reveals that 54.2 % of males received the vaccination, while 45.8 % did not (Table 2). Among females, the vaccination rate was 55.6 %, with 44.4 % remaining unvaccinated. However, the association between gender and vaccination was not significantly ( $p > 0.05$ ) different. Similarly, the odds ratio in the multivariate analysis indicated slightly higher odds of vaccination for males compared to females, although the association was not statistically significant ( $p > 0.05$ ).

Regarding age, the univariate analysis showed variations in vaccination rates across different age groups. The highest vaccination rate was observed in the 26 - 35 years age group with 61.6 % vaccinated, while the lowest rate was among the 36 - 45 years age group at 29.2 %.

The chi-square test suggests a significant ( $p = 0.001$ ) association between age and vaccination status (Table 2).

The multivariate analysis further confirms these findings, indicating higher odds of vaccination for the 26 - 35 years age group when compared to the reference group (18 - 25) (Table 3). Affiliation as examined in the univariate analysis, demonstrated differences in vaccination rates among various affiliations. Public service showed a vaccination rate of 59.0 %, while private practice had a rate of 60.2 %. However, only the association between affiliation and vaccination reached statistical significance ( $p = 0.034$ ) in the chi-square test (10.40). The odds ratio in the multivariate analysis indicated slightly lower odds of vaccination for the public service group compared to private practice, but the association was not statistically significant ( $p > 0.05$ ) (Table 3). Based on occupation, Veterinarians had the highest number of pre-exposure vaccination with an odd ratio of 5.13 followed by Veterinary clinical students and para-veterinarians (Table 3). Table 4 shows the Multivariate analysis of association between selected variables. There was a higher odd in occupation with Veterinarians having the most significant ( $p = 0.001$ ).

#### **DISCUSSION**

Rabies is an endemic disease that kills approximately 59,000 persons mostly in low- and middle-income countries (Subedi *et al.*, 2022). This study showed that 54.2 % of the respondents were vaccinated against rabies and this disagrees with the work of Adetayo *et al.* (2021) who reported 18.6 % in a prevalence study of rabies pre-exposure vaccination and risk perception. We postulate that this could be due to the advent of more information being passed in the media about rabies and people having more awareness about the disease in Nigeria (Al-Mustapha *et al.*, 2021). From this study, 126 respondents were not vaccinated, we postulate the reasons could be due to cost, availability, cultural beliefs and misconceptions, lack of awareness, low perceived risk and fear of potential adverse effects.

Respondents working in the private and public sectors had the highest percentage of pre-exposure vaccination. This can be attributed to the level of education already attained by these individuals and also the financial capability to afford the vaccine (Al-Mustapha *et al.*, 2022). Supporting this observation, a report from the Federal Ministry of Agriculture and Rural Development, Nigeria (FMARD) on Veterinarians in Federal and state ministries of Agriculture indicated that out of a total of 1302 veterinarians, the North West region accounted for the highest number of veterinarians with 498 (38.2 %), while the South East region had the lowest number with 55 (4.2 %) in the public service (FMARD, 2022). Among veterinarians, 62.5% were vaccinated, while only 30.8% of Para veterinarians received the vaccine, this finding is consistent with results of a previous study (Blanton *et al.*, 2018). The chi-square test indicated a significant association between occupation and vaccination status. The multivariate analysis confirmed these findings, showing significantly higher odds of vaccination for veterinarians compared to other occupations. This may be because veterinarians probably have a better understanding of the benefits of vaccination. They may be aware of the potential risks associated with certain diseases and the importance of vaccines to prevent them, more so in Nigeria, there is no regulatory requirement for dog breeders, wildlife workers and animal handlers to receive rabies pre-exposure vaccines (Daodu *et al.*, 2017; Al-Mustapha *et al.*, 2022). These findings provide insights for targeted interventions and educational campaigns to improve vaccination rates among specific subgroups, such as younger individuals and those in occupations other than veterinary practice. Although the overall coverage of vaccination is moderate, there are variations in different variables such as age, occupation and practice area. Based on the findings of this study, several recommendations can be made to strengthen rabies prevention strategies among

occupationally exposed humans in Nigeria; (I) Improve education and awareness: implement targeted educational campaigns to increase awareness of the importance of rabies vaccination among persons exposed to the work. This should address false statements, highlight the benefits of vaccination and provide information on the availability and cost-effectiveness of vaccines. (II) Improve access and affordability: Improve access to rabies vaccines, especially in vulnerable areas. Cooperate with health systems, government agencies and NGOs to ensure the availability and affordability of vaccines for people exposed to the workplace. (III) Strengthen occupational health policies: Develop and implement occupational health policies that mandate rabies vaccination before exposure for high-risk occupational groups. This helps to create a safer working environment and protect people from potential viruses. (IV) Collaborate with professional associations: Collaboration with professional associations of veterinarians, animal technicians and other relevant professional groups to promote vaccination programmes, provide rabies prevention training and disseminate guidelines and best practices. (V) Improve surveillance and reporting: Improve surveillance systems to monitor cases of rabies and occupational exposure. This can help identify areas and occupations at high risk, inform targeted interventions and measure the impact of vaccination programmes.

#### **CONCLUSION**

This study was able to assess rabies vaccination status of occupationally high-risk individuals with 54.2 % of the respondent vaccinated. The study provides insights into the current rabies prevention situation and highlights areas for improvement.

#### **DECLARATION OF COMPETING INTEREST**

The authors declare that no competing interests exist.

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None to be declared

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**Table 1:** Distribution of Variables and Responses

<b>Variables</b>	<b>Categories</b>	<b>Number or respondents (%)</b>
<b>Gender</b>	Male	192 (69.8)
	Female	81 (29.5)
	Prefer not to say	2 (0.7)
	Total	275 (100)
<b>Age</b>	18-25	39 (14.2)
	26-35	198 (72.0)
	36-45	24 (8.7)
	45 and above	14 (5.1)
	Total	275 (100)
<b>Occupation</b>	Veterinarians	200 (72.7)
	Para Veterinarian	13 (4.7)
	Clinical Student	51 (18.5)
	Dog Breeders	3 (1.1)
	Zoo Keepers	1 (0.4)
	Others	7 (2.5)
	Total	275 (100)
<b>Region of Practice</b>	South East	16 (5.8)
	South South	29 (10.5)
	South West	23 (8.4)
	North East	37 (13.5)
	North Central	52 (18.9)
	North West	118 (42.9)
Total	275 (100)	
<b>Affiliation</b>	Public Service	105 (38.2)
	Private Practice	103 (37.5)
	Military/ Paramilitary	3 (1.1)
	Non-Governmental Organization	13 (4.7)
	Clinical Student	51 (18.5)
	Total	275 (100)



<b>Received Rabies pre-exposure Vaccination</b>	Yes	149 (54.2)
	No	126 (45.8)
	Total	275 (100)
<b>Health Insurance</b>	Yes	87 (31.6)
	No	188 (68.4)
	Total	275 (100)
<b>Do you wish to take the vaccine for free?</b>	Yes	266 (96.7)
	No	9 (3.3)
	Total	275 (100)

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**Table 2:** Univariate analysis, showing the association between pre-exposure vaccination and various variables such as gender, age, affiliation, region of practice, and occupation

Variables	Category	Pre-exposure vaccination			Chi Square	P Value
		Yes (%)	No (%)	Total		
<b>Gender</b>	Male	104 (54.2)	88 (45.8)	192	12.23	0.09
	Female	45 (55.6)	36 (44.4)	81		
<b>Age</b>	Prefer not to say	0	2 (100)	2	16.26 <sup>a</sup>	0.001*
	18-25	15 (38.5)	24 (61.5)	39		
	26- 35	122 (61.6)	76 (38.4)	198		
	36-45	7 (29.2)	17 (70.8)	24		
<b>Affiliation</b>	45 and above	5 (35.7)	9 (64.3)	14	10.40	0.034*
	Public Service	62 (59.0)	43 (41.0)	105		
	Private Practice	62 (60.2)	41 (39.8)	103		
	Military/Para-military	1 (33.3)	2 (66.7)	3		
	Clinical Student	20 (39.2)	31 (60.8)	51		
	Non-governmental Organization	4 (44.4)	5 (55.6)	9		
<b>Region of Practice</b>	South East	6 (37.5)	10 (62.5)	16	9.32	0.097
	South South	16 (55.2)	13 (44.8)	29		
	South West	14 (60.9)	9 (39.1)	23		
	North East	13 (35.1)	24 (64.9)	37		
	North Central	32 (61.5)	20 (38.5)	52		
	North West	68 (57.6)	50 (42.4)	118		
<b>Occupation</b>	Veterinarians	125 (62.5)	75 (37.5)	200	29.37	0.000*
	Para Veterinarian	4 (30.8)	9 (69.2)	13		
	Clinical Student	17 (33.3)	34 (66.7)	51		
	Dog breeders	3 (100)	0 (0.0)	3		
	Zoo Keepers	0 (0.0)	1 (100)	1		
	Others	0 (0.0)	7 (100)	7		

\*Significantly different at  $p < 0.05$

**Table 3:** Multivariate analysis which examines the adjusted association between some selected variables and rabies pre-exposure vaccination

Variables	Category	Pre-exposure vaccination			Odd ratio	95 % CI
		Yes (%)	No (%)	Total		
<b>Gender</b>	Male	104 (54.2)	88 (45.8)	192	1.26	0.545
	Female	45 (55.6)	36 (44.4)	81		
<b>Age</b>	Prefer not to say	0	2 (100)	2	2.43	1.175
	18-25	15 (38.5)	24 (61.5)	39		
	26- 35	122 (61.6)	76 (38.4)	198		
	36-45	7 (29.2)	17 (70.8)	24		
<b>Affiliation</b>	45 and above	5 (35.7)	9 (64.3)	14	0.75	0.474
	Public Service	62 (59.0)	43 (41.0)	105		
	Private Practice	62 (60.2)	41 (39.8)	103		
	Military/ParaMilitary	1 (33.3)	2 (66.7)	3		
	Clinical Student	20 (39.2)	31 (60.8)	51		
	Non-governmental Organization	4 (44.4)	5 (55.6)	9		
	South East	6 (37.5)	10 (62.5)	16		
<b>Region of Practice</b>	South South	16 (55.2)	13 (44.8)	29	0.81	0.627
	South West	14 (60.9)	9 (39.1)	23		
	North East	13 (35.1)	24 (64.9)	37		
	North Central	32 (61.5)	20 (38.5)	52		
	North West	68 (57.6)	50 (42.4)	118		
	Veterinarians	125 (62.5)	75 (37.5)	200		
	Para Veterinarian	4 (30.8)	9 (69.2)	13		
	Vet Clinical Student	17 (33.3)	34 (66.7)	51		
	Dog breeders	3 (100)	0 (0.0)	3		
	Zoo Keepers	0 (0.0)	1 (100)	1		
Others	0 (0.0)	7 (100)	7			

**Table 4:** Multivariate analysis of association between selected variables

<b>Variables</b>	<b>Category</b>	<b>Odd ratio</b>	<b><i>p</i> value</b>	<b>95 % CI</b>
<b>Gender</b>	Male	1.26	0.03	0.9 – 2.02
	Female	Ref		
<b>Age</b>	Prefer not to say		0.01	0.11 – 3.18
	18-25	Ref		
	26- 35	2.43		
	36-45	0.67		
<b>Occupation</b>	45 and above	0.21	0.001	0.1 – 5.46
	Veterinarians	5.13		
	Para Veterinarian	0.53		
	Vet Clinical Student	2.91		
	Dog breeders	0.04		
	Zoo Keepers	Ref		
	Others	0.15		