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Rabies exposure and prophylaxis among dog owners in Ogun State, Nigeria: a descriptive and categorical analysis of knowledge, attitudes and practices

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Abstract

Background: Rabies, a deadly viral human-animal disease, remains endemic in Nigeria. Identifying gaps in rabies knowledge, attitudes, and practices among dog owners in communities within Southwestern Nigeria remains a public health goal. This cross-sectional study investigated the knowledge of and attitudes to rabies exposure, prophylaxis and associated factors, and practices during rabies exposure and prophylaxis among dog owners in Ogun State, Nigeria.

Methods: Using multistage sampling technique, 500 dog owners were randomly selected and interviewed with a pre-tested structured questionnaire. Data collected on their socio-demographics, knowledge of and attitudes to



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rabies exposure and prophylaxis, and practices during rabies exposure and prophylaxis were evaluated using descriptive and categorical analysis.

Results: The majority of the respondents were female (53.0%; 265 respondents of 500 respondents), 32 years old (54.6%; 273 of 500), and had primary and secondary education (53.2%; 266 of 500 respondents). The majority (60.0%; 300 of 500 respondents) allowed their dogs to roam the streets, but only 120 (24.0%) had vaccinated their dogs up to date. Of the 500 respondents, 145 (29%) had experienced dog bites, but few (4.1%; 6 of 145) received rabies vaccine, and even fewer (2.8%; 4 of 145) completed the regimen. Proportions of respondents with knowledge, attitudes, and practices associated with higher rabies risks were 37.8%, 59.4%, and 97.6%, respectively. Age ($P = 0.01$), education ($P = 0.04$), short-term dog ownership ($P = 0.01$), and occupation ($P = 0.01$) were factors associated with their practices in relation to higher rabies risks.

Conclusion: The knowledge, attitudes, and practices of dog owners towards rabies exposure portends a high risk. Public health interventions to achieve behavioural change, and the enforcement of dog vaccination and leash laws are highly recommended.

Keywords: Dog owners, rabies awareness, exposure risk, behavioural change, Ogun State, Nigeria

INTRODUCTION

Rabies is a zoonosis caused primarily by the rabies virus. Rabies can also be caused by infection from other members of the Lyssavirus genus^[1,2]. Rabies affects the central nervous system (CNS) of humans, as well as warm-blooded domestic and wild mammals. It is well-known that dogs are the most affected animals^[3]. Rabies is most commonly spread through infected saliva, particularly from bites by affected dogs. The disease can be prevented and eliminated by vaccinating at least 70% of dogs to break the transmission cycle^[1]. Despite being vaccine-preventable, rabies remains endemic in Africa, where an estimated 21,000 to 25,000 people die from the disease annually^[4]. In Nigeria, a West African country, rabies still poses a significant public health threat. Thousands of people die of rabies annually and prevalence rates ranging from 3% to 28% have been reported among dogs in different regions of the country^[5]. The domestic dog is the most common transmitter of rabies in Nigeria and many cases of rabies are due to bites by dogs, especially free-roaming dogs^[6]. The Dogs Law, which was enacted in Nigeria in 1943 and has explicit provisions on compulsory dog registration, dog confinement, and dog rabies vaccination, is rarely enforced and it was only recently revised in a few states^[7]. Consequently, the country has yet to attain the World Organisation of Animal Health's international standard of prohibiting the straying of dogs^[8]. Researchers have also reported the knowledge, attitudes, and practices considered to increase rabies exposure risk among people in some parts of the country^[9].

Furthermore, dog bites and rabies cases are rarely reported to hospitals and this has led to an increase in the risk of dog-mediated human rabies^[10]. Reporting dog bites and rabies cases ensures the availability of data necessary for sample collection, laboratory diagnosis, and planning and implementing rabies elimination programmes, including prompt post-exposure vaccination of dog bite victims and organisation of rabies education campaigns. The limited reportage of rabies cases has contributed to limited investment in rabies elimination interventions in Nigeria, like many other African countries^[11]. Data are also essential for developing models pivotal to any in-depth understanding of disease dynamics and identifying and implementing prevention and control measures. Such models were developed to analyse the spread and control of rabies^[12] and other infectious diseases, such as the novel coronavirus disease (COVID-19) that has had devastating global impacts^[13]. Ogun State has been identified as one of the states with the largest population of dogs in Southwestern Nigeria^[14]. That rabies vaccination coverage among the dog population

in the state is lower than the 70% recommended by the World Health Organisation has been reported in the state^[15]. Hence, the residents are at a high risk of rabies exposure, and this raises concerns about the progress towards achieving the global strategic plan to end human deaths from dog-mediated rabies by the year 2030^[16]. Since health literacy is pivotal in the prevention and control of infectious diseases^[17], this study was conducted to assess the knowledge of and attitudes to rabies exposure and prophylaxis, as well as the practices and other associated factors that affect rabies exposure and prophylaxis among dog owners in Ogun State, Nigeria.

METHODS

The study was conducted in Ogun State, Southwestern Nigeria, from July 2020 to July 2021. The sample size was calculated using the formula $n = Z^2P(1-P)/d^2$ ^[18], where n was the sample size, Z was the level of confidence (95%), P was the expected prevalence (50% was used), and d was precision (5%). The formula yielded a minimum sample size of 384. Seven (i.e., one-third) of the 20 Local Government Areas (LGAs) in Ogun State were selected using systematic random sampling. Two wards per LGA ($n = 14$) were randomly selected and six streets per ward ($n = 84$) were then selected using systematic random sampling. A total of five hundred ($n = 500$) dog-owning houses were selected from the streets. Using the face-to-face interviewer method, a pre-tested and structured questionnaire with close-ended questions, which were grouped into four sections, was used to collect data on the dog owners' socio-demographic characteristics, knowledge of and attitudes to rabies exposure and prophylaxis and the dog owners' practices during rabies exposure and prophylaxis. Scoring of their knowledge, attitudes, and practices was done as described in a previous study^[19]. To score the respondents' knowledge, attitudes and practices in relation to rabies exposure and prophylaxis, each correct option to the questions was assigned one (1) point, while the incorrect options were assigned zero (0) point. Only respondents with at least an average of the total correct points were deemed to possess the knowledge, attitudes, and practices associated with lower rabies risk. In addition, any dog owner whose dog was not vaccinated against rabies up to date was regarded to demonstrate practices associated with higher rabies risk.

Statistical analysis

Data obtained from the study were analysed using descriptive statistics and the Chi-square test to identify the association between the socio-demographic characteristics of the dog owners, their knowledge of and attitudes to rabies exposure and prophylaxis, and their practices in the context of rabies exposure and prophylaxis. The level of significance was set at $\alpha = 0.05$ ^[20].

RESULTS

Socio-demographic characteristics of dog owners interviewed in Ogun State

Of the 500 dog owners, the majority (53.0%; 265 of 500) were female; younger than 32 years (54.6%; 273 of 500); of the Yoruba ethnic group ($n = 456$; 91.2%; 456 of 500); had primary to secondary education (53.2%; 266 of 500); owned private businesses (34.2%; 171 of 500) and had kept dogs continuously for five years or less (52.0%; 260 of 500) [Table 1].

Awareness and knowledge of dog owners about rabies

Of the 500 dog owners, a vast majority (86.4%; 432 of 500) had heard about rabies before mostly from friends and family members (46.5%; 201 of 500), less than half (37.4%; 187 of 500) knew that other mammals, besides dogs, could be infected with rabies, 135 (27.0%) stated that only adult and stray dogs could be infected and 62 (12.4%) knew that rabies could be transmitted through licks and contact of infected saliva with skin wounds and mucous membranes. Only 118 (23.6%) knew dogs could be rabid yet be calm. About a quarter (23.2%; 116 of 500) believed that herbs and concoctions, which have not been scientifically proven to be effective, were capable of preventing rabies [Table 2].

Table 1. Socio-demographic characteristics of dog owners interviewed in Ogun State

Variable	Category	Frequency	Percentage (%)
Sex	Male	235	47.0
	Female	265	53.0
Tribe	Yoruba	456	91.2
	Igbo	35	7.0
	Hausa	3	0.6
	Others	6	1.2
Age (years)	≤ 32	273	54.6
	> 32	227	45.4
Level of education	No formal education	15	3.0
	Primary to secondary education	266	53.2
	Tertiary	219	43.8
Occupation	Dog breeders	91	18.2
	Unemployed	89	17.8
	Students	88	17.6
	Civil servants	61	12.2
	Private business owners	171	34.2
Number of years of keeping dogs	≤ 5	260	52.0
	> 5	240	48.0

Attitude of dog owners to rabies

More than half of the respondents (50.4%; 252 of 500) stated they could play with any dog, regardless of the vaccination status. More than one-third of the dog owners (35.8%; 179 of 500) believed that free-roaming of dogs was acceptable. About half (42.0%; 210 of 500 respondents) claimed reporting cases of dog bites at the hospitals was unnecessary, and only one-quarter (25.2%; 126 of 500) thought it was not necessary to submit samples from suspected rabid animals for laboratory testing [Table 3].

Practices of dog owners during rabies exposure and prophylaxis

More than two-thirds of the respondents (65.8%; 329 of 500) had direct contact with dogs on a daily basis, but only about a fifth (20.8%; 104 of 500) practised good hand hygiene afterwards. The majority (60.0%; 300 of 500) allowed their dogs to roam freely in the neighborhood. Yet, less than a quarter (24.0%; 120 of 500) had vaccinated their dogs up to date. The reasons given for non-compliance with up-to-date dog rabies vaccination included lack of awareness (26.1%; 99 of 380), high cost of the vaccine (48.4%; 184 of 380 respondents), and unavailability (13.2%; 50 of 380) in their areas.

Of the 500 dog owners, 145 (29.0%) had experienced dog bites. Only 12 of these (8.3%, 12 of 145 dog bite victims) practised the acceptable wound-washing procedure immediately after the incident; only 22.1%, 32 of 145 dog bite victims, used herbs or concoctions; only 23.4%, 34 of 145 dog bite victims, reported at a medical facility. Six (4.1%) of the 145 dog bite victims took post-exposure rabies vaccine, but only four (2.8%) of the victims completed the regimen. The reasons given by the two victims who failed to complete the PEP regimen were the high cost of the human rabies vaccine and the long distance of the hospitals to their homes [Table 4].

Socio-demographic characteristics of respondents and their knowledge of rabies

The age ($P = 0.001$), level of education ($P = 0.02$), number of years of keeping dogs ($P = 0.001$), and occupation ($P = 0.01$) of the respondents were significantly associated with their knowledge about rabies. Younger respondents, those with primary to secondary education, those who had kept dogs for fewer years, and the unemployed had levels of knowledge associated with higher rabies risk [Table 5].

Table 2. Awareness and knowledge of dog owners about rabies

Variable	Response	Frequency	Percentage (%)
Heard of rabies before	Yes	432	86.4
	No	68	13.6
First source of information about rabies	Family/friends	201	46.5
	School	99	22.9
	Veterinary/human hospital	31	7.2
	Mass media	70	16.2
	Social media	12	2.8
	Rabies campaign	19	4.4
Besides dogs, rabies can affect other mammals	Yes	187	37.4
	No	229	45.8
	I don't know	84	16.8
Only adult and stray dogs can be infected with rabies	Yes	135	27.0
	No	185	18.5
	I don't know	180	18.0
Rabies leads to the death of affected hosts	Yes	361	72.2
	No	51	10.2
	I don't know	88	17.6
Rabies can be transmitted through the bites and scratches of an infected animal	Yes	376	75.2
	No	55	11.0
	I don't know	69	6.9
Rabies can be transmitted through licks and contact with infected saliva with skin wounds and mucous membranes	Yes	62	12.4
	No	331	66.2
	I don't know	107	21.4
Dogs with rabies show sudden changes in behaviour, hypersalivation, and aggression	Yes	346	69.2
	No	82	16.4
	I don't know	72	14.4
Some dogs may have rabies and yet be calm	Yes	118	23.6
	No	287	57.4
	I don't know	95	19.0
Rabies can be prevented by vaccination	Yes	319	63.8
	No	79	15.8
	I don't know	102	20.4
Rabies can be prevented by the drinking or rubbing of herbs and traditional concoctions on dog bite wounds or by taking medications	Yes	116	23.2
	No	233	46.6
	I don't know	151	30.2
Overall levels of knowledge about rabies	Knowledge associated with lower rabies risk	311	62.2
	Knowledge associated with higher rabies risk	189	37.8

Socio-demographic characteristics of respondents and their attitudes to rabies

The sex ($P = 0.01$), age ($P = 0.001$), level of education ($P = 0.001$), number of years of keeping dogs ($P = 0.001$), and occupation ($P = 0.001$) of the respondents were significantly associated with their attitudes towards rabies. Females, younger respondents, those with no formal education, and those who had kept dogs for five years or less had attitudes associated with higher rabies risk [Table 6].

Table 3. Attitudes of dog owners to rabies exposure and prophylaxis

Statement	Strongly agree (%)	Agree (%)	Undecided (%)	Disagree (%)	Strongly disagree (%)
I can play with any dog in my community regardless of whether it is vaccinated against rabies or not	37.8	12.6	4.0	19.2	26.4
Free roaming of dogs should be allowed in the community	26.0	9.8	19.4	16.2	28.6
Cases of dog bites in animals and humans do not have to be reported to the hospital	29.6	12.4	4.2	25.0	28.8
It is best to receive treatment in the hospital after being bitten by an animal	39.6	2.6	7.0	8.4	42.4
It is not necessary to submit samples from suspected rabid animals for laboratory testing	10.4	14.8	16.2	16.6	42.0
Overall levels of attitude towards rabies	Attitude associated with lower rabies risk			40.6	
	Attitude associated with higher rabies risk			59.4	

Table 4. Practices of dog owners during rabies exposure and prophylaxis

Variable	Category	Frequency	Percentages (%)
Frequency of direct contact with dogs	Daily	329	65.8
	Less frequently	171	34.2
I wash my hands with soap and water or use sanitiser after direct contact with dogs	Yes	104	20.8
	No	396	79.2
I allow dogs to roam freely in their communities	Yes	300	60.0
	No	200	40.0
I comply with up-to-date vaccination of dogs	Yes	120	24.0
	No	380	76.0
Reasons for not vaccinating dogs up to date	Lack of awareness	99	26.1
	High cost	184	48.4
	Unavailability	50	13.2
	Others	47	12.4
I have experienced dog bites in the past	Yes	145	29.0
	No	355	71.0
Actions taken after dog bites	Washed bite wound with soap and water immediately	12	8.3
	Applied antiseptics	63	43.4
	Drank or rubbed herbs/concoction	32	22.1
	Visited the hospital	34	23.4
	Did nothing	4	2.8
As a bite victim, I reported to the hospital immediately	Yes	4	11.8
	No	30	88.2
Took post-exposure prophylaxis (PEP)	Yes	6	4.1
	No	139	95.9
I completed the PEP regimen	Yes	4	2.8
	No	143	97.2
Reasons for not completing the PEP regimen	High cost of human anti-rabies vaccine and the far distance of the hospital to the victim's home	2	100
Overall levels of preventive practices towards rabies	Practices associated with lower rabies risk	12	2.4
	Practices associated with higher rabies risk	488	97.6

Socio-demographic characteristics of respondents and their practices during rabies exposure and prophylaxis

The respondents' age ($P = 0.01$), level of education ($P = 0.001$), number of years of keeping dogs ($P = 0.01$),

Table 5. Respondents' socio-demographic characteristics and their knowledge about rabies

Variable	Knowledge		X ²	df	P-value
	Associated with lower rabies risk n (%)	Associated with higher rabies risk n (%)			
Sex					
Male	149 (63.4)	86 (36.6)	0.27	1	0.67
Female	162 (61.1)	103 (38.9)			
Age (years)					
≤ 32	147 (53.8)	126 (46.2)	17.85	1	0.001 [†]
> 32	164 (62.2)	63 (27.8)			
Level of education					
No formal education	9 (60.0)	6 (40.0)	7.61	2	0.02 [†]
Primary to secondary	151 (56.8)	115 (43.2)			
Tertiary	151 (68.9)	68 (31.1)			
Number of years of keeping dogs					
≤ 5	135 (51.9)	125 (48.1)	23.43	1	0.001 [†]
> 5	176 (73.3)	64 (26.7)			
Occupation					
Dog breeder	63 (69.2)	28 (30.8)	13.14	4	0.01 [†]
Unemployed	46 (51.7)	43 (48.3)			
Student	46 (52.3)	42 (47.7)			
Civil servant	44 (72.1)	17 (27.9)			
Private business owner	112 (65.5)	59 (34.5)			

X²: Chi square; †df: degree of freedom; †P-values ≤ 0.05 are significant.

and occupation ($P = 0.02$) were significantly associated with their practices during rabies exposure and prophylaxis. Younger respondents, those with no formal education, and those who had kept dogs for five years or less had attitudes associated with higher rabies risk [Table 7].

Association between respondents' knowledge of, attitudes to, and practices during rabies exposure and prophylaxis

There were significant associations between the dog owners' knowledge of and attitudes to rabies exposure and prophylaxis ($P = 0.008$), knowledge of rabies and practices during rabies exposure and prophylaxis ($P = 0.0001$), and their attitudes to and practices during rabies exposure and prophylaxis ($P = 0.0001$). The majority (54.7%) of the respondents with knowledge associated with lower rabies risk had attitudes associated with lower rabies risk. The majority (74.0%) of those with knowledge associated with lower rabies risk exhibited practices associated with lower rabies risk, and the majority (63.1%) of those with attitudes associated with lower rabies risk exhibited practices associated with lower rabies risk [Table 8].

DISCUSSION

Rabies remains a disease of great public health concern and economic burden in Nigeria. This study identified knowledge gaps and attitudes and practices associated with higher rabies risk among dog owners in Ogun State, Southwestern Nigeria. The findings are essential for planning community-based strategies and resource allocation for rabies elimination in Ogun State, Nigeria. From this study, the majority (84.6%) of the dog owners were aware of rabies. This is similar to the 86.9% reported in a study on rabies awareness among dog owners in Abeokuta, Ogun State^[15]. The most common sources of the first information about rabies (46.5%) were friends and family members. This finding is consistent with that of a similar study in Oyo State, Nigeria^[21] and another one in Ghana^[22]. Such informal channels have the disadvantages of limited

Table 6. Respondents' socio-demographic factors and their attitudes to rabies

Variable	Attitude		X ²	df	P-value
	Associated with lower rabies risk n (%)	Associated with higher rabies risk n (%)			
Sex					
Male	109 (46.4)	126 (53.6)	6.15	1	0.01 [†]
Female	94 (35.5)	171 (64.5)			
Age (years)					
≤ 32	70 (25.6)	203 (74.4)	54.44	1	0.001 [†]
> 32	133 (58.6)	94 (41.4)			
Level of education					
No formal education	0 (0.0)	15 (100.0)	140.45	2	0.001 [†]
Primary to secondary	50 (18.8)	216 (81.2)			
Tertiary	153 (69.9)	66 (30.1)			
Number of years of keeping dogs					
≤ 5	75 (28.8)	185 (71.2)	30.02	1	0.001 [†]
> 5	128 (53.3)	112 (46.7)			
Occupation					
Dog breeder	35 (38.5)	56 (61.5)	95.39	4	0.001 [†]
Unemployed	50 (56.2)	39 (43.8)			
Student	35 (39.8)	53 (60.2)			
Civil servant	52 (85.2)	9 (14.8)			
Private business owner	31 (18.1)	140 (81.9)			

X²: Chi square; df: degree of freedom; P-values ≤ 0.05 are significant.

reach and the possibility of spreading incorrect information. This indicates the need to adopt the One Health approach involving veterinarians, medical doctors, and other concerned professionals in the dissemination of authentic information about rabies to stop its spread in animal and human populations.

Furthermore, only 37.4% of the respondents knew that, besides dogs, other mammals could be infected with rabies. This is similar to a work in Oyo State, Nigeria, which reported that only 37.5% of its respondents were aware that other mammals could be infected by rabies^[21]. This reveals a knowledge gap as rabies has been reported in other mammals in Nigeria^[23]. Only a few (12.4%) knew rabies could spread through licks and contacts of the saliva of an infected animal with skin wounds and mucous membranes; thus, this indicates that non-bite exposure to rabies is not commonly known and should be included in rabies education programmes. More than a third (36.2%) of the respondents did not know rabies could be prevented by vaccination. This is in tandem with a previous report in Ogun State^[24] and calls for more extensive enlightenment on the importance of vaccination for canine and human rabies prevention. The majority of the respondents had attitudes associated with higher rabies risk, as more than half (50.4%) indicated that they could play with any dog regardless of its vaccination status. Meanwhile, most rabies cases in Nigeria have been attributed to stray, free-roaming, and unvaccinated dogs^[5]. Attitudes towards reporting the cases of dog bites in animals and humans to the hospital and submitting samples from suspected rabid animals for laboratory testing pose a higher risk of rabies exposure. These negative attitudes contribute to the underreporting of rabies cases, resulting in extremely limited data essential for the adequate supply of the resources needed for rabies elimination^[25].

Table 7. Respondents' socio-demographic factors and their practices during rabies exposure and prophylaxis

Variable	Practice		X ² *	df [†]	P-value [‡]
	Associated with lower rabies risk n (%)	Associated with higher rabies risk n (%)			
Sex					
Male	59 (25.1)	176 (74.9)	0.19	1	0.66
Female	61 (23.0)	204 (77.0)			
Age (years)					
≤ 32	53 (19.4)	220 (80.6)	6.39	1	0.01 [†]
> 32	67 (29.5)	160 (70.5)			
Level of education					
No formal education	0 (0.0)	15 (100.0)	54.03	2	0.001 [†]
Primary to secondary	33 (12.4)	233 (87.6)			
Tertiary	87 (39.7)	380 (60.3)			
Number of years of keeping dogs					
≤ 5 years	49 (18.8)	211 (81.2)	7.31	1	0.01 [†]
> 5	71 (29.6)	169 (70.4)			
Occupation					
Dog breeders	26 (28.6)	65 (71.4)	11.86	4	0.02 [†]
Unemployed	28 (31.5)	61 (68.5)			
Student	20 (22.7)	68 (77.3)			
Civil servant	42 (68.9)	19 (31.1)			
Private business owner	27 (15.8)	144 (84.2)			

X²: Chi square; df: degree of freedom; P-values ≤ 0.05 are significant.

Table 8. Association between respondents' knowledge of, attitudes to, and practices during rabies exposure and prophylaxis

Knowledge	Attitude		X ²	df	P-value
	Associated with higher rabies risk n (%)	Associated with lower rabies risk n (%)			
Associated with lower rabies risk	141 (45.3)	170 (54.7)	7.17	1	0.008 [†]
Associated with higher rabies risk	127 (67.2)	62 (32.8)			
Knowledge	Practices		X ²	df	P-value
	Associated with higher rabies risk n (%)	Associated with lower rabies risk n (%)			
Associated with lower rabies risk	81 (26.0)	230 (74.0)	15.24	1	0.0001 [†]
Associated with higher rabies risk	168 (88.9)	21 (11.1)			
Attitude	Practices		X ²	df	P-value
	Associated with higher rabies risk n (%)	Associated with lower rabies risk n (%)			
Associated with lower rabies risk	75 (36.9)	128 (63.1)	55.91	1	0.0001 [†]
Associated with higher rabies risk	270 (90.9)	27 (9.1)			

X²: Chi square; df: degree of freedom; P-values ≤ 0.05 are significant.

With as high as 60.0% of the respondents allowing their dogs to roam freely, there is an increase in the environmental risk of rabies transmission. Many cases of dog-mediated human rabies have been associated with bites by free-roaming dogs, and the risk of rabies spillover from free-roaming dogs to other domestic animals as well as wildlife has been reported in Nigeria^[26]. The enforcement of laws prohibiting straying and free-roaming of dogs is therefore pivotal to environmental protection geared towards rabies prevention and

One Health optimisation. Furthermore, with only about a quarter (24.0%) of the respondents complying with up-to-date rabies vaccination of their dogs, the risk of rabies from dog bites is high. Dog vaccination coverage lower than the 70% WHO-recommended level is equally a major challenge in some other African countries^[27], and this may make achieving the “Zero by Thirty” goal difficult.

Almost a third (29.0%) of the respondents had experienced dog bites. This is lower than the 78% reported in a study in Kwara State, Nigeria^[9]. However, only a few respondents who had experienced dog bites (8.3%) practised immediate wound washing with soap and water after the bite, as recommended by the WHO^[1]. Hence, public health education on first aid rabies prevention in dog bite victims is expedient. Some 22.1% of the dog bite victims used herbs or concoctions to prevent rabies. This serves as proof that the use of traditional medicine to treat diseases is a common practice in Nigeria^[28]. Such a practice may be contributing to the high prevalence of human rabies in Africa. Only a few (23.4%) of the dog bite victims reported to the hospital for wound management and assessment for rabies vaccine uptake. This is lower than the 61.8% reported in another study in which respondents were from Ogun State^[24] and indicates a decline in healthcare-seeking behaviour in the state. The delayed reporting to the hospital by the majority of the dog bite victims (88.2%) may increase the risk of dog-mediated human rabies. Furthermore, only six of the dog bite victims (4.1%) took the Post-exposure Prophylaxis (PEP). This is lower than the 66.25% previously reported in the state^[24]. A third of those who took the PEP (33.3%) failed to complete the regimen due to the high cost of the human rabies vaccine and the long distance from the hospital to their homes. This means that low economic power and limited access to healthcare facilities hinder rabies' PEP uptake and increase the risk of dog-mediated human rabies. Educating the public on the importance of taking complete doses of rabies PEP and wider distribution of subsidised or free human rabies vaccine to remote communities can contribute to addressing these challenges.

The overall levels of knowledge, attitudes, and practices associated with higher rabies risk in this study were 37.8%, 59.4%, and 97.6%, respectively. Similar findings have been reported in some other states of Nigeria^[9]. Age, education, dog ownership, and occupation were the factors associated with rabies-preventive practices. Knowledge, attitudes, and practices associated with higher rabies risks were observed among younger respondents, those with low or no formal education, those who had only owned dogs for a few years, and private business owners. This observation is consistent with those of a number of previous studies in Nigeria^[29]. Researchers in China^[30] also reported that bite victims of suspected rabid dogs with lower levels of education were less likely to exhibit practices associated with lower rabies risk. Hence, these factors should be captured in rabies education programmes. This study has also revealed that a greater proportion of dog owners with higher levels of rabies knowledge had attitudes and engaged in practices associated with lower rabies risk, as similarly reported by two previous studies^[31,32]. Organising programmes aimed at improving rabies knowledge and ensuring behavioural changes in various settings, such as schools and communities, will immensely contribute to rabies prevention and control. For instance, including rabies education in school curricula has been proven to have significantly increased rabies knowledge. Rabies knowledge improvement has resulted in the reduction of dog bite cases and rabies risk among school children^[33].

In conclusion, the rabies knowledge level among the dog owners interviewed in this study was moderately high. However, knowledge gaps regarding rabies hosts, transmission, signs, and prevention were identified. Their attitudes to and practices, especially regarding dog vaccination compliance, post-exposure first aid measures, and prophylaxis, are of great public health concern. Targeting dog owners of younger age, with low levels of education, owning private businesses, and who have only kept dogs for a few years in rabies education programmes is of utmost importance. To achieve rabies elimination in Ogun State and fulfil the

global goal of zero human dog-mediated rabies deaths by 2030, there is an urgent need for the adoption of the One Health approach involving all the concerned stakeholders in implementing rabies education programmes, free mass dog vaccination, rabies surveillance, enforcement of dog's law and extensive supply of free or subsidised human rabies vaccines.

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Authors' contributions

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Availability of data and materials

The data collection materials and datasets generated during this study are available and can be accessed through the corresponding author on reasonable request.

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Conflicts of interest

All authors declared that there are no conflicts of interest.

Ethical approval and consent to participate

The ethical approval for the study was obtained from the University of Ibadan/University College Hospital (UI/UCH) Ethics Committee, Institute for Advanced Medical Research and Training (IAMRAT), College of Medicine, University of Ibadan, Ibadan, Nigeria with the assigned number: UI/EC/20/0150.

The informed consent documents read and signed by the participants in this study were reviewed and approved by the University of Ibadan/University College Hospital (UI/UCH) Ethics Committee, Institute for Advanced Medical Research and Training (IAMRAT), College of Medicine, University of Ibadan, Ibadan, Nigeria.

Consent for publication

Written informed consent documents to publish the data obtained from the study were obtained from all the dog owners.

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