Konzing L
National Veterinary Research
Institute (NVRI) Vom,
Outstation and Extension
Division, Shendam, Plateau
State, Nigeria.

Umoh JU
Department of Veterinary
Public Health and Preventive
Medicine, Faculty of
Veterinary Medicine, Ahmadu
Bello University, Zaria,
Nigeria.

Dzikwi AA
Department of Veterinary
Public Health and Preventive
Medicine, Faculty of
Veterinary Medicine, Ahmadu
Bello University, Zaria,
Nigeria.

Trade dog-dog meat processors interface in rabies transmission

Konzing L, Umoh JU, Dzikwi AA

Abstract
Consumption of dog meat is a common practice in some parts of Nigeria, particularly in Plateau State, and dog trade is a thriving business with dog markets in many local government areas of the state. There are reports of the presence of rabies antigen in the brains of slaughtered dogs. This study was carried out to determine the presence of rabies antigens in slaughtered dogs for human consumption, assess the knowledge, attitude and practice of dog meat processors to rabies and check for the presence of rabies antibodies in dog meat processors in Plateau state which could indicate evidence of infection during processing of dog meat. Two hundred and three dog heads were purchased from dogs slaughtered in Jos south ("Kasuwan kare"), Kanke (Amper and Dawaki) and Shendam Local Government Areas (LGA) of Plateau State to detect the presence of rabies antigens using fluorescent antibody test. Structured and pretested questionnaires were administered to 92 dog meat processors that participated in the study in order to assess their knowledge, attitude and practice towards rabies. Serum samples obtained from the 92 dog meat processors were processed for antibodies to rabies using enzyme-linked immunosorbent assay (ELISA). Of the 203 dog brain samples, 10 (4.93%) were positive for rabies antigen. Following the interviews, 74% of the respondents had good knowledge about rabies, 87% of the respondents had positive attitude toward rabies and 88% of the respondents had good practice towards rabies control and prevention. Despite having good knowledge about rabies, it was observed that some dog meat processors did not wear hand gloves, face masks and eye goggles when processing dog meat. Thirteen (14%) of the dog meat processors had antibodies to rabies virus. It can be concluded that the rabies antigen was present in some of the dogs slaughtered for human consumption and even though dog meat processors had good knowledge about rabies, they did not protect themselves when processing dog meat and some of them may have been exposed to the rabies virus. Dog meat processors should be educated on how they are to protect themselves against exposure to rabies during dog meat processing.

Keywords: Antibodies, Antigen, Processors, Questionnaire, Rabies, Nigeria.

1. Introduction
Rabies is an acute neurological disease caused by a lyssavirus that attacks the central nervous system of all warm blooded animals and humans and is normally a fatal viral infection (Wunner. 2009) [15]. Dogs are only moderately susceptible to rabies but are without doubt the animals most likely to spread the infection to human beings (Nadin-Davis *et al.*, 2008) [11]. In Nigeria canine rabies is endemic and records indicate that the frequency of occurrence of rabies cases in dogs is over 96% of all the reported animal rabies cases (WHO, 2005) [14].
Dog meat is consumed as a special delicacy in some communities in Nigeria (Ajayi *et al.*, 2006) [1]. Even though dog meat consumption is particularly common in Plateau, Cross River, Kaduna, Akwa Ibom, Kebbi and Ondo states, it occurs in all states of Nigeria particularly in major towns. Plateau state has some of the most flourishing dog markets in Nigeria. Dawaki and Amper markets in Kanke Local Government area receive dogs from all the northern states and from Niger and Chad Republics (Sabo, 2009) [13] and from these markets, dogs are transported to all the southern states. This mobility in dog population could contribute to the spread of rabies.
Several surveys have reported the detection of rabies antigen in the brains of dogs slaughtered for human consumption in Katsina and Sokoto States (Garba *et al.*, 2010) [8], Kaduna (Odeh *et al.*, 2013) [12], Cross River (Isek, 2013) [10], Benue (Akombo, 2009) [2], Plateau (Sabo, 2009) [13] and Lagos (Hambolu *et al.*, 2013) [9]. Most if not all of these dogs

Correspondence
Konzing L
National Veterinary Research
Institute (NVRI) Vom,
Outstation and Extension
Division, Shendam, Plateau
State.

looked apparently healthy at the time of slaughter. There are reports from Africa and elsewhere which indicate that some rabid dogs may not die but recover and continue to live as carriers (Arko *et al.*, 1973; Bell, 1975; Fekadu, 1975) [3, 4, 7]. Thus the presence of rabies virus in some of the slaughtered dogs constitute a great public health hazard to the dog handlers and dog meat processors. This risk may be increased if the dog handlers and meat processors are deficient in the knowledge of rabies, have negative attitudes towards taking precautionary measures during dog handling, slaughtering and meat processing and if they carry out practices that may increase the possibility of exposure.

In general, dog meat processing provides an interface of dogs, some of which may have rabies, with dog meat processors most of whom take no precautionary measures during dog meat processing. Rabies transmission can take place at this interface. If a processor is infected subclinically, then antibody should be detected in the blood.

The objectives of this study were to check for rabies antigen in the brains of dogs slaughtered and processed for human consumption, to assess the knowledge, attitudes and practices of the dog meat processors towards rabies and to assess for evidence of infection in these dog meat processors.

2. Materials and Methods
2.1 Study design
This was a descriptive cross sectional study conducted from June to October 2012.

2.2 Study area
Plateau state is bounded by Bauchi state to the north east, Kaduna state to the northwest, Nassarawa state to the southwest and Taraba state to the south east. It has an area of 26,899 Km^2 and an estimated population of 3.5 million people, it is located between latitude 81o24'N and 10o30'N and longitude 81o32E' and 10o38'E (Blench *et al.*, 2003) [5]. The three locations where the study was conducted were Bukuru, Kanke and Shendam (Figure 1). Bukuru is located about 13km south of Jos, the state capital and has a large dog market "kugia" where slaughtering of dogs take place and some of the dog meat is taken to other parts of the state. Kanke, located in central senatorial zone of plateau state has two major dog markets which receive dogs from neighbouring states and Niger and Chad Republics. Shendam located in the southern part of the state has among other dog markets, a popular one "kasuwan dare".
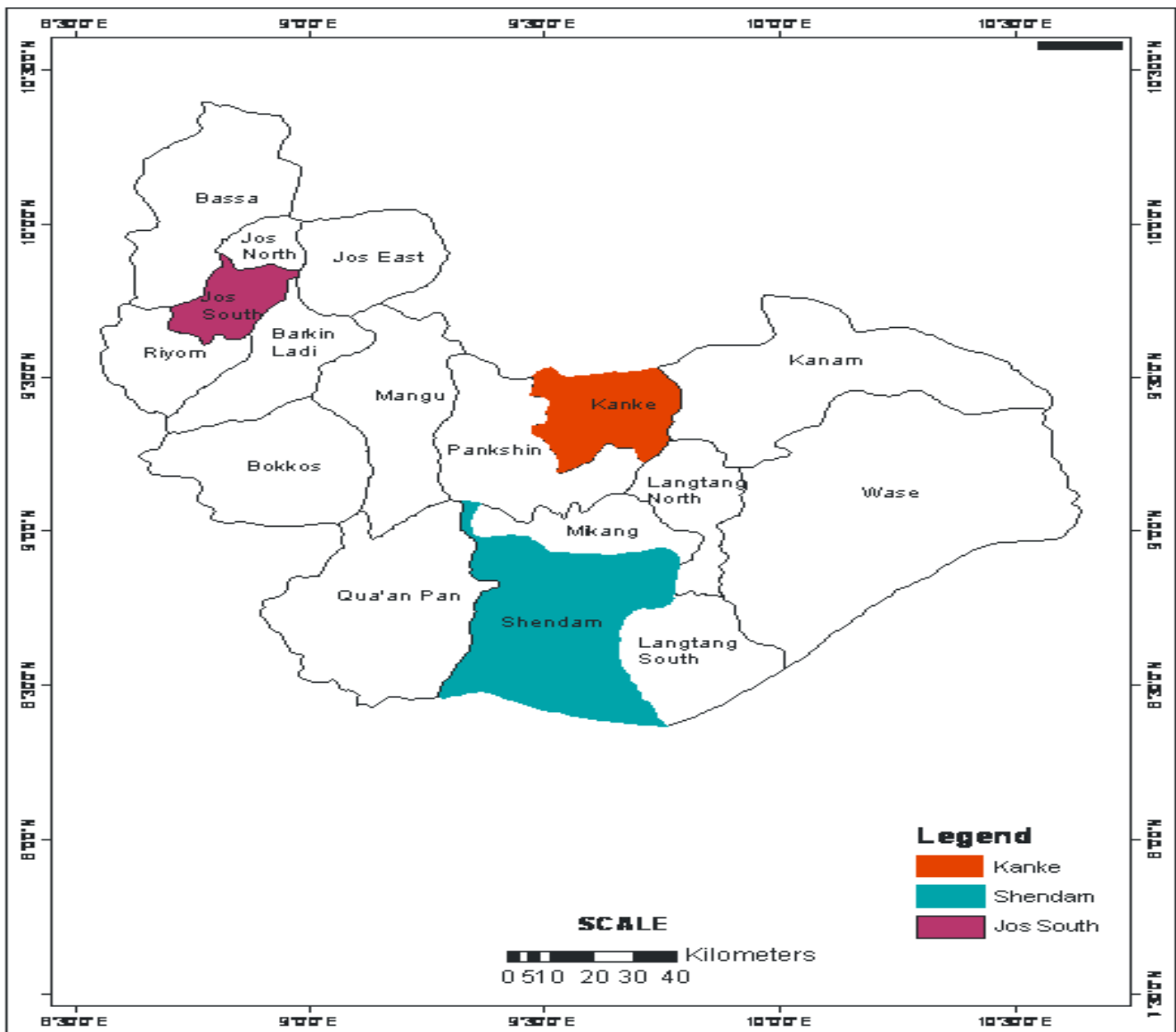

Fig 1: Study Areas Marked in colours on the Map of Plateau State.
Source: Adapted and modified from Plateau State administrative map

2.3 Study population
a) Slaughtered dogs
Dogs slaughtered for human consumption in Bukuru (kasuwan Kare), Kanke (Dawaki and Amper markets) and Shendam (Kasuwan Dare) were sampled for detection of rabies antigen.
b) Dog meat processors who were present at the time of the visit to the dog markets and were willing to participate were included in the study

2.4 Brain sample collection
A total of 203 brain samples were collected from adult dogs slaughtered in the dog markets in the three selected local government areas as follows: 146 from Bukuru, 48 from Kanke and 9 from Shendam. The samples of hippocampus obtained were transported in cold chain to the Viral Zoonoses Laboratory of the Department of Veterinary Public Health and Preventive Medicine, A.B.U, Zaria and stored at -20°C until analysed. Information on the source of the dogs was obtained by interviewing the dog meat processors.

2.5 Flourescent antibody test (FAT)
This was carried out as described by Dean *et al.*, (1996) [6] using flourescein isothiocyanate labelled anti-rabies monoclonal globulin lot 9C 03711 from Fujirebio Diagnostics Inc. Briefly, impression smears of samples were made on glass slides, air-dried and fixed in cold acetone at -20 °C for 1 hour. The smears were air-dried and stained with adequately diluted anti-rabies conjugate for 30 minutes at 37 °C in a humid chamber. The slides were then washed with phosphate buffered saline (PBS, pH7.4), air-dried and examined using a fluorescent microscope (MEIJI TECHNO MT 600 microscope, Saitama, Japan). The presence of clear-cut rounded dots or clusters of apple green fluorescence indicates the presence of rabies antigen.

2.6 Collection of serum samples from dog meat processors
With the assistance of nurses from the Plateau State Ministry of Health, blood samples were collected from 92 dog meat processors who were willing to participate in the study and from whom brain samples from the dogs they slaughtered were obtained for rabies antigen detection.

2.7 Detection of antibody to rabies virus
This was done by enzyme linked immunosorbent assay (ELISA) using human anti-rabies virus antibody ELISA kit catalog no 23073 produced by BIOMEDICAL ASSAY Hai Dian District, Beijing, China marketed by Antibodies Online.com in Germany. The avidin-peroxidase conjugate was used and the test was done as recommended by the kit manufacturer. The absorbance was read at 450nm within 30 minutes of adding the stop solution.

2.8 Interpretation of ELISA
The percentage blocking (PB) was calculated as described in the manufacturer's manual.
$$PB\% = \{(OD_{NC}-OD_{sample})/(OD_{NC}-OD_{PC})\} \times 100$$
where OD_{NC} is the optical density of the negative control, OD_{sample} is the optical density of the sample and OD_{PC} is the optical density of the positive control.
Percentage blocking greater than 70%, indicating antibody levels higher than 0.5IU/ml, as provided by the kit manufacturer was considered positive. Percentage blocking less than 70% was considered negative.

2.9 Knowledge attitude and practice (KAP) of dog meat processors to rabies
Data were collected using a structured questionnaire on the 92 dog meat processors whose dogs were checked for rabies antigen and who were willing to have blood drawn for rabies antibody assay. Prior to the study, the questionnaire was pilot-tested on 20 dog meat processors to check for understanding and clarity and was refined accordingly. The participants of the pilot study were not included in the final analysis, internal consistencies were checked for the questionnaire with knowledge items having Cronbach's value of 0.82 and attitude items having Cronbach's alpha of 0.64.
The survey was in Hausa Language. Only one researcher carried out face to face interview on all the respondents. The questionnaire had four parts. The first part was used to collect demographic information of the respondents (age, sex, tribe, marital status and occupation). The second part consisting of 21 items collected information on knowledge about rabies which included questions about the disease, mode of transmission, clinical signs/symptoms, prevention and control. The third part consisted 8 items on perception (attitude) of the respondents about rabies while the fourth consisting of 6 items tested the practices of the respondents especially on rabies prevention.

2.10 Ethical consideration
The Ethics Committee of the Ministry of Health Plateau State approved the study. Copies of the approval were submitted to the respective local government health authorities where the dog markets were located. Consent of the community heads and leaders of the dog meat processors was obtained prior to the study. They assisted in encouraging the processors to participate in the study. Verbal consent was sought and obtained from each dog meat processor. The cooperation of the processors was overwhelming.

2.11 Data analysis
The rate of rabies antigen detection was calculated as a proportion of the total number of dog brain samples examined. For KAP, data from the questionnaires were analysed using the Statistical Package for Social Sciences (SPSS) version 18.0 SPSS Inc., Chicago, USA. Questions on knowledge, attitude and practice had choices as yes, no and no idea or undecided. A marking scheme was prepared and used to mark the responses and scores allocated. On each question, 1 point was awarded for a correct answer and 0 point for an incorrect answer or no idea or undecided. Higher score indicated a greater level of knowledge, a more positive attitude or a more acceptable practice toward rabies prevention. Demographic variables and responses to the questions were expressed as frequencies. Bivariate analysis was used to assess the associations between demographic variables and categorised knowledge, attitude and practice scores and results of serological test. Odds ratio (OR) and 95% confidence intervals on the ORs were calculated. Chi square (χ^2) analysis was used in some cases to check associations between categorical variables. Multivariate logistic regression was applied to assess associations between demographic variables and categorized scores that had p-values <0.20 in bivariate analysis. Adjusted odds ratio (AOR) and their 95% confidence intervals (CIs) were calculated. Multiple regression analysis was utilized to test for correlation among knowledge, attitude and practice

scores. A p-value of 0.05 was adopted as the level of significance.

3. Results
3.1 Rabies antigen in dog brain
Of the 203 dog brain samples tested, 10 (4.95%) were positive for rabies antigen. Five samples out of 146 (3.42%), 4 out of 48 (8.33%) and one out of 9 (11.11%) samples were positive in Bukuru, Kanke and Shendam respectively. Of the 33 dogs sourced from Zamfara state, 3 were positive and of the 23 samples sourced from Plateau State 2 (8.60%) were positive. Dogs sourced from Kano, Borno, Bauchi and Yobe States and from Chad Republic had one positive sample each (Table 1).

3.2 Demographic characteristics of the dog meat processors.
Table 2 summarises the demographic characteristic of the respondents. About 66.3% were females, 84.8% were married, 97.8% were self-employed and 70.7% indicated having been bitten by a dog previously.

Table 1: Distribution of dog brain positive for rabies antigen by sex, Local Government Area and by source of specimens in Plateau State Nigeria.

Characteristic	Number Sampled	Number of positive samples (%)
Sex		
Males	101	5(4.95)
Females	102	5(4.90)
Total	203	10(4.93)
L.G.A		
Jos South	146	5(3.42)
Kanke	48	4(8.33)
Shendam	9	1(11.11)
Total	203	10(4.93)
Source (Reported by processors)		
Kano State	46	1(2.17)
Zamfara State	33	3(9.10)
Plateau State	23	2(8.60)
Niger State	19	0(0.00)
Borno State	13	1(7.60)
Bauchi State	18	1(5.55)
Yobe State	12	1(8.33)
Niger Republic	31	0(0.00)
Chad Republic	08	1(12.50)
Total	203	10(4.93)

Table 2: Demographic characteristics of the dog meat processors (N=92) sampled in Jos South and Kanke LGA of Plateau State, between Nov. 2012 and Jan. 2013

Variables	Frequency (%)
Sex	
Males	31 (33.7)
Females	61 (66.3)
Ages groups	
20-30	23 (25.0)
31-40	34 (37.0)
>40	35 (38.0)
Marital Status	
Single	14 (15.2)
Married	78 (84.8)
Occupation	
Civil servant	2 (2.2)
Business men&women/farmers	90 (97.8)
Qualification	
No formal education	14 (15.2)
Primary education	45 (48.9)
Secondary and tertiary	33 (35.9)
Location of respondent	
Kanke	27 (29.3)
Jos south	65 (70.7)
Ownership of dogs	
None	50 (54.3)
1	15 (16.3)
2	11 (12.0)
≥ 3	16 (17.4)
Dog bite victim	
Yes	65 (70.7)
No	27 (29.3)

Even though 75% of the respondents knew that all dogs can be infected and can also transmit the rabies virus, 79.3% that dogs are the common source of rabies in Nigeria, 65.2% that all human beings can be infected with rabies, 68.5% that rabies can be spread through saliva of a rabid animal, yet only 46.7% knew that rabid dogs should not be slaughtered for human consumption and 47.8% knew that those involved in slaughtering dogs and processing dog meat have a high probability of being infected (Table 3). Only 30.4% of the respondents knew that excessive foamy salivation and tendency to bite at anything are signs of rabies in dogs.

Bivariate analysis showed significant associations of sex and location of sampling with level of knowledge. Male respondents were more likely to have good knowledge than females (OR 3.29. 95% CI on OR 1.01-10.70). Respondents from Kanke were more likely to have good knowledge than those from Bukuru (OR= 3.82, 95% CI on OR 1.03-14.13, Table 4). These associations were, however, not significant in the multivariate logistic regression analysis (Table 5).

Table 3: Responses of the dog meat processors in Jos South and Kanke LGA of Plateau State, to statements on knowledge of rabies.

Questions	Yes (%)	No (%)	No Idea (%)
Rabies kills only animals.	32 (34.8)	49 (53.3)	11 (12.0)
The rabies virus is only found in the nerves.	43 (46.7)	10 (10.9)	39 (42.4)
All dogs can be infected and can also transmit the rabies virus.	69 (75.0)	6 (6.5)	17 (18.5)
Dogs are the common source of rabies in Nigeria	73 (79.3)	8 (8.7)	11(12.0)
A dog that bites without provocation is likely to be rabid	58 (63.0)	19 (20.7)	15 (16.3)
All humans can be infected with rabies	60 (65.2)	32 (34.8)	
Bite from an infected animal cannot spread rabies to other animals	38 (41.3)	35 (38.0)	19 (20.7)
Rabies can be spread through the saliva of a rabid animal	63 (68.5)	7 (7.6)	22 (23.9)
Those involved in slaughtering and processing dog meat for human consumption are likely to be infected with rabies virus	44 (47.8)	32 (34.8)	16 (17.4)
An infected human being can transmit rabies to another	35 (38.0)	33 (35.9)	24 (26.1)
A mad dog should not be slaughtered for consumption	43 (46.7)	41 (44.6)	8 (8.7)

A friendly dog that suddenly turns aggressive may have rabies	58 (63.0)	25 (27.2)	9 (9.8)
A person that has rabies may not like to drink water	18 (18.6)	31 (33.7)	43 (46.7)
Excessive foamy salivation and tendency to bite anything are not signs of rabies in dogs	45 (48.9)	28 (30.4)	19 (20.7)
Is it right to vaccinate dog(s) against rabies?	83 (90.2)	2 (2.2)	7 (7.6)
Dog registration and licensing help in control of rabies	72 (78.3)	7 (7.6)	13 (14.1)
Vaccination of dogs against rabies should be annual	82 (89.1)	4 (4.3)	6 (6.5)
Do you know that contact with a sick dog can cause danger to your health?	70 (76.1)	22 (23.9)	-

Table 4: Associations between demographic variables and categorized knowledge scores of dog meat processors in Jos South and Kanke Local Government Areas of Plateau State, Nigeria (Nov. 2012 – Jan. 2013) Categorised knowledge score

Variables	Good (%)	Poor (%)	Total	Odds Ratio (95% CL)	χ^2 value	P value
Sex						
Male	27 (87.10)	4 (12.90)	31	3.29(1.01-10.70)	4.215	0.047 *
Female	41(67.20)	20(32.80)	61	Ref		
Age Group						
20-30	20 (87.00)	3 (13.00)	23	3.94(0.97-15.88)	4.360	0.113
31-40	26 (76.50)	8 (23.50)	34	1.92 (0.67–5.48)		
>40	22 (62.90)	13 (37.10)	35	Ref		
Marital Status						
Single	10 (71.40)	4 (28.60)	14	0.86 (0.24–3.06)	0.400	0.754
Married	58 (74.30)	20 (25.70)	78	Ref		
Qualification						
No formal education	9 (64.30)	5 (35.70)	14	0.58 (0.15–2.23)	0.794	0.672
Primary education	34 (75.60)	11 (24.40)	45	0.99 (0.35–2.82)		
Secondary/ tertiary	25 (75.80)	8 (24.20)	33	Ref		
Occupation						
Civil servant	2 (100)	0	2			
Business men/women	66 (73.30)	24(26.70)	90			
Location of Respondents						
Kanke	24 (88.90)	3 (11.10)	27	3.82(1.03-14.13)	4.445	0.040 *
Jos south	44 (67.70)	21(32.30)	65	Ref		
Dog bite victims						
Yes	49 (75.40)	16(24.60)	65	1.29 (0.47–3.51)	0.249	0.612
No	19 (70.40)	8 (29.60)	25	Ref		
Dog ownership status						
None	41 (82.00)	9 (18.00)	50	2.07 (0.58–7.45)		
1	8 (53.30)	7 (46.70)	15	0.52 (0.12–2.25)	5.241	0.263
2	8 (72.70)	3 (27.30)	11	1.21 (0.22–6.62)		
≥3	11 (70.00)	5 (30.00)	16	Ref		

* $p < 0.05$

Table 5: Multivariate logistic regression analysis to assess association between demographic variables and categorised knowledge scores of respondents in Kanke and Jos south LGA of Plateau state, between Nov. 2012 and Jan. 2013.

Categorised knowledge scores	Good: AOR(95% CI)	Poor: AOR(95% CI)
Intercept		
Sex		
Male	2.55 (0.602-10.860)	0.391 (0.092- 1.661)
Female	Ref	Ref
Age		
20-30	2.325 (0.512-10.551)	0.430 (0.095-1.953)
31-40	1.699 (0.505-5.719)	0.588 (0.175-1.980)
> 40	Ref	
Location		
Jos South	0.132 (0.014-1.223)	7.596 (0.818-70.539)
Kanke	Ref	Ref
Dog ownership		
None	23.972 (1.331-431.705)	0.042 (0.002-0.751)
1	6.276 (0.315-125.104)	0.159 (0.008-3.177)
2	17.584 (0.745-415.023)	0.057 (0.002-1.342)
3	6.944 (0.372-129.787)	0.144 (0.008-2.691)
>3	Ref	

AOR = Adjusted odd ratio, CI = Confidence interval

3.3 Attitude towards rabies

In general, 87.0% of the respondents had positive attitudes towards rabies prevention (OR=6.6, 95% CI on OR 0.81-53.74), those with no formal education (OR=0.06 95% CI on OR 0.01-0.54) and those with only primary education (OR=0.20, 95% CI on OR 0.02-1.78) were less likely to have positive attitude than those with second/tertiary education. All the respondents from Kanke had positive attitude towards

rabies prevention (Table 6).

About 82.6% of the respondents agreed that dog meat processors should wear protective clothes. However, 77.2% of them indicated that they do not wear hand gloves while processing dog meat. A high proportion of the respondents (89.1%) said that dog handlers should receive human anti-rabies vaccine yearly but only 63.0% knew that bite wounds should be washed with soap and water (Table 7). Chi square analysis showed on association between age group and categorised practice scores (p<0.05). Younger processors were more likely to have good practice tendencies than those over 40 years of age. Respondents in the 31-40 year groups had significantly better practice score than those in the greater than 40 years group (OR=9.78 95%CI on OR 1.15,83.16) (Table 8). Pearson correlation coefficient showed that dog meat processors with higher knowledge had significantly more positive attitude towards rabies prevention (r=0.431, p<0.05). However, the correlation coefficient between attitude and practice scores was not statistically significant r = 0.090, p>0.05, Table 9). Compared with those with secondary/tertiary education, those with lower level of education had poorer practice scores (Table 8).

3.4 Detection of antibodies to rabies virus in dog meat processors.
Thirteen dog meat processors (14.13%), 8 from Bukuru and 5 from Kanke, were positive for antibodies to rabies virus (Table 10). The distribution of the presence of the antibodies by demographic variables of the respondents is shown in Table 9. Testing for associations between KAP scores and having antibodies to rabies showed that dog processors with good knowledge were 4.9 times more likely to be positive for antibodies than those with poor knowledge but this association was not significant (OR=4.929, 95%CI on OR 0.605, 40.125) (Table 11). Also, there was no significant association between having good practice score and being antibody positive (OR=1.739, 95% CI on OR 0.204, 14.857).

Table 6: Associations between demographic variables and categorised attitude scores of dog meat processors in Jos South and Kanke Local Government Areas of Plateau state, Nigeria Between Nov. 2012 – Jan. 2013. Categorised attitude score

Variable	Positive (%)	Negative (%)	Total	Odds Ratio (95% CL)	χ^2 value	P value
Sex						
Males	30 (96.80)	1 (33.33)	31	6.6 (0.81-53.74)	3.973	0.054 *
Females	50 (82.00)	11 (18.00)	61	Ref		
Age Group						
20-30	22 (95.70)	1 (4.30)	23	5.50(0.63 48.12)		
31-40	30 (88.20)	4 (11.80)	34	1.88 (0.49–7.11)	3.076	0.215
>40	28 (80.00)	7 (20.00)	35	Ref		
Marital Status						
Single	12 (85.71)	2 (14.30)	14	0.88 (0.17–4.54)	6.810	1.000
Married	68 (87.18)	10 (12.82)	78	Ref		
Qualification						
No formal education	9 (64.30)	5 (35.70)	14	0.06 (0.01–0.54)		
Primary education	39 (86.70)	6 (13.30)	45	0.20 (0.02–1.78)	9.265	0.010 *
Secondary/tertiary	32 (97.00)	1 (3.0)	33	Ref		
Occupation						
Civil servant	2 (100)	0	2			
Business men/women	78 (81.50)	12 (18.50)	90			
Location of Respondents						
Kanke	27 (100)	0	27			
Jos south	53 (81.50)	12 (18.50)	65			
Dog bite victims						
Yes	57 (87.70)	8 (12.30)	65	1.24 (0.34-4.54)	0.106	0.742
No	23 (85.20)	4 (14.80)	27	Ref		
Dog ownership status						
None	44 (88.00)	6 (12.00)	50			
1	12 (80.00)	3 (20.00)	15			
2	8 (72.72)	3 (27.27)	11			
≥3	16 (100)	0	16			

* *p* < 0.05

Table 7: Responses of the dog meat processors in Jos south and Kanke LGA of Plateau state, to statements on practices toward rabies prevention.

Questions	Yes	No	Undecided
It is good to vaccinate dogs	90 (97.8)	2 (2.2)	-
Dog handlers should wear protective clothes	76 (82.6)	6 (6.5)	10 (10.9)
Castration/spaying of dogs is bad	42 (45.7)	22 (23.9)	28 (30.4)
It is good to wash dog bites wounds with soap and water	58 (63.0)	28 (30.4)	6 (6.5)
Dog handlers should receive human anti-rabies vaccine yearly	82 (89.1)	6 (6.5)	4 (4.3)
Do you wear hand gloves when processing dog meat	14 (15.2)	71 (77.2)	7 (7.6)

Table 8: Associations between demographic variables and categorised practice scores of some dog meat processors in Jos South and Kanke local government areas of Plateau state, Nigeria Between Nov. 2012 - Jan. 2013. Categorised practice score

Variables	Good (%)	Poor (%)	Total	Odds Ratio (95% CL)	*p* value
Sex					
Males	29 (93.30)	2 (6.50)	31	2.51 (0.51–12.41)	0.323
Females	52 (85.20)	9 (14.80)	61	Ref	
Age Group					
20-30	21(91.30)	2 (8.70)	23	3.11 (0.60–16.22)	
31-40	33 (97.10)	1 (2.90)	34	9.78 (1.15–83.16)	0.033*
>40	27 (77.10)	8 (22.90)	35	Ref	
Marital Status					
Single	13 (92.90)	1 (7.10)	14	1.91 (0.22–16.25)	1.000
Married	68 (77.30)	10 (13.00)	78	Ref	
Qualification					
No formal education	11 (78.60)	3 (21.40)	14	0.11 (0.01–1.22)	0.12
Primary education	38 (84.40)	7 (15.60)	45	0.68 (0.15–3.06)	
Secondary/tertiary	32 (97.00)	1 (3.00)	33	Ref	
Occupation					
Civil servant	2 (100)	0	2		
Business men/women	79 (87.80)	11 (12.22)	90		
Location of Respondents					
Kanke	26 (96.30)	1 (3.70)	27	4.73 (0.57–38.93)	0.165
Jos south	55 (84.60)	10 (15.40)	65	Ref	
Dog bite victims					
Yes	58 (89.20)	7 (10.80)	65	1.42 (0.38–5.31)	0.725
No	23 (85.20)	4 (14.80)	27	Ref	
Dog ownership status					
None	46 (92.00)	4 (8.00)	50	1.64 (0.27–9.94)	
1	12 (80.00)	3 (3.30)	15	0.57 (0.08–4.01)	0.600
2	9 (81.81)	2 (18.18)	11	0.64 (0.08–5.42)	
≥3	14 (87.50)	2 (12.50)	16	Ref	

* $P < 0.05$

Table 9: Correlations between knowledge, attitude and practice scores of dog meat processors in Jos south and Kanke LGA of Plateau State (Nov. 2012 and Jan. 2013).

Knowledge scores	Attitude scores	Practice scores	
Knowledge scores			
Pearson correlation	1	0.431*	0.353*
Significance		0.000	0.001
Attitude scores			
Pearson correlation	0.431*	1	0.090
Significance	0.000		0.394

* Significant at $P < 0.01$, Pearson correlation coefficient

Table 10: Results of rabies antibodies of respondents among dog meat processors in Jos south and Kanke Local government areas (LGA) of Plateau state between November, 2012 and January, 2013.

Variable	Positive sample (%)	Negative sample (%)	Total
Location			
Jos south	8 (12.3)	57 (87.7)	65
Kanke	5 (18.5)	22 (81.5)	27
Age			
20-30	4 (17.4)	19 (82.6)	23
31-40	2 (5.9)	32 (94.1)	35
>40	7 (20)	28 (80)	35
Sex			
Male	7 (22.6)	24 (77.4)	31
Female	6 (9.8)	55 (90.2)	61
Occupation			
Civil servant	0	2 (100)	2
Businessman/woman	13 (14.4)	77 (85.6)	90
Tribe			
Berom	3 (7.9)	35 (92.1)	38
Ngas	8 (16.7)	40 (83.3)	48
Others	2 (33.3)	4 (66.7)	6
Qualification			
No formal education	3 (21.4)	11 (78.6)	14
Primary	4 (8.9)	41 (91.1)	45
Secondary/tertiary	6 (18.2)	27 (81.8)	33

Table 11: Associations between knowledge, attitude and practice scores of respondents and with results of serological test for rabies antibody in Jos South and Kanke LGA of Plateau State. ELISA test result

Variabe	Positive (%)	Negative (%)	Total	OR(95% CI on OR)
Categorised knowledge Scores				
Good	12(17.6)	56(82.4)	68	4.929(0.605-40.125)
Poor	1(4.2)	23(95.8)	24	
Categorised attitude scores				
Good	13(16.3)	67(83.8)	80	
Poor	0	12(100)	12	
Categorised practice scores				
Good	12(14.8)	69 (85.2)	81	1.739(0.204-14.857)
Poor	1(9.1)	10(90.9)	11	

4. Discussion

This study has demonstrated the interface between dogs and dog meat processors with regards to risk of exposure to rabies. The risk of exposure stems from some of the dogs slaughtered for consumption having rabies antigen in their brains; some of the processors being bitten during dog handling and slaughtering and not washing bite wounds and cuts with soap and water; most processors having poor knowledge of the risk involved and being involved in poor practices such as not wearing protective clothing during processing.

The presence of rabies antigens in the brain samples from the slaughtered dogs indicates that there is a possibility of the dog meat processors being exposed to rabies as most of them take no particular precautions to prevent exposure during meat processing. Plateau State has several dog markets with the major ones being at Kanke Local Government Area. Dog traders travel to various rural areas in northern states of Nigeria and even to Niger and Chad Republics to purchase dogs (usually in exchange for some items) and transport them to markets in Plateau State. From there some are transported to various towns in Southern Nigeria for slaughter. The detection of rabies antigen in the brains of some of these dogs indicate the occurrence of inapparent rabies and possibly a carrier state. Rabies antigen has been demonstrated in brains of slaughtered dogs collected from Lagos (Hambolu *et al.,* 2013) [9], Ogoja (Isek *et al.,* 2013) [10], Plateau state (Sabo, 2009) [13], Makurdi (Akombo, 2009) [2] and several other towns in Nigeria. This shows that rabies could be spread very easily in Nigeria through dog trade.

Male dog meat processors were more knowledgeable about rabies than females because they move around to source for dogs and thus are more familiar with them. Processors in Kanke LGA were also more knowledgeable than those from Bukuru and Shendam. Kanke has major markets where dogs are brought in from all parts of the north and transported to all parts of the south. The live dog trade was done mainly by males and 65% of the processors in Kanke were males. Females were involved mainly in post-slaughter processing.

The low proportions of processors who knew that rabid dogs should not be slaughtered for human consumption, who knew that dog meat processing could lead to exposure to rabies and who knew the clinical signs of rabies in dogs were probably responsible for the high degree of risky behaviour observed during dog meat processing.

The respondents had daily contact with dogs and therefore had developed to a large extent, positive attitudes toward rabies prevention. The degree of having positive attitude increases with the level of education and level of involvement in dog trade especially among the male respondents.

The revelation that 77.2% of the respondents reported not wearing protective gloves during dog meat processing and the actual observation during the survey that virtually none of them protected themselves while at work show the extent of risk of exposure to rabies. Their practice does not seem to match their response that dog meat processors should wear protective clothing during processing and should receive anti-rabies pre-exposure vaccination. Processors who were below 40 years of age had higher level of education and had better practice scores than older ones.

The presence of rabies antibodies in the serum samples of some processors is an indication that some of them were exposed to and infected with rabies virus which manifested as inapparent infection.

The triad of knowledge, attitude and practice are linked in such a way that any increase in knowledge leads to more positive attitude and to good practice towards rabies prevention. Since knowledge has significant influence on attitude and practice, efforts should be targeted at educating dog meat processors to improve practices towards prevention of exposure to rabies while processing dog meat.

This study has established the presence of rabies antigen in the brain of some dogs slaughtered in Plateau State; that some processors are bitten by the dogs during handling and slaughtering; that processors have some deficiencies in their knowledge of rabies; that processors take no precautionary measures to prevent exposure to rabies during processing of dog meat and that some of the processors may have been infected inapparently as indicated by the presence of antibodies in their sera.

Thus, dog meat processors are highly vulnerable to rabies infection especially as they have poor knowledge of the risk their occupation involves. Health education is necessary to reduce the risk and avert clinical rabies in dog meat processors. The cooperation of the local government health officials, community leaders and leaders of the dog meat processors facilitated the participation of dog meat processors as only very few of them refused to participate in the study when approached.

Limitation**:** Even though this study has assessed the possible risk of dog meat processors being exposed to rabies, the results were obtained from only 92 respondents. The questionnaire design was based on" yes /no and don't know" format options with a high probability of guessing which was not controlled. The study was a cross-sectional survey and may not have been able to assess the true association between knowledge and practices.

References
1. Ajayi BB, Rabo JS, Baba SS Rabies. in apparently healthy dogs: Histological and immunohistochemical studies. The Nigerian Postgraduate Medical Journal. 2006; 13:128-134.
2. Akombo PM. Dog Ecology and Epidemiological Studies of Canine Rabies in Benue State, Nigeria. Ahmadu Bello University, Zaria, Nigeria. M.Sc. Thesis. 2009, 60.
3. Arko RJ, Schneider LG, Baer GM. Non-fatal rabies. American Journal of Veterinary Research. 1973; 34:937-938.
4. Bell JF, Baer GM. Latency and Abortive Rabies in: the

Natural History of Rabies. Academic Press, New York, 1975, 331-354.

5. Blench RM, Daniel P, Umaru H. Access rights and conflict over common pool resources in three states in Nigeria. Report to Conflict Resolution Unit, World Bank, 2003.

6. Dean DJ, Albelseth MK, Atanasiu P. The fluorescent antibody test:I Laboratory Techniques In: Rabies. Meslin, F-X., Kaplan, M.M. and Koprowski, H. (Eds.) 4th edition. WHO, Geneva, 1996, 88-89.

7. Fekadu M. Asymptomatic non-fatal canine rabies. Lancet 1975; 1:569

8. Garba A, Oboegbulem SI, Junaidu AU, Magaji AA, Umoh JU, Ahmed A *et al.* Rabies virus antigen in the brain of apparently healthy dogs in Sokoto and Katsina States, Nigeria. Nigerian Journal of Parasitology. 2010; 31(2):123-125.

9. Hambolu ES, Dzikwi AA, Kwaga JKP, Kazeem HM, Umoh JU, DA. Rabies and dog bites cases in Lagos State Nigeria: A Prevalence and retrospective studies (2006-2011). Global Journal of Health Science. 2013; 6(1):107-114.

10. Isek TI. Epidemiological studies of Canine Rabies in Ogoja, Cross River State. M.Sc Thesis. Ahmadu Bello University, Zaria, Nigeria. 2013, 15-56.

11. Nadin-Davis SA, Casey GA, Wandeler AI. A molecular epidemiological study of rabies virus in central Ontario and western Quebec. Journal of General Virology. 2008; 75:2575-2583

12. Odeh EL, Umoh JU, Dzikwi AA. Assessment of Risk of Possible Exposure to Rabies among Processors and Consumers of Dog Meat in Zaria and Kafanchan, Kaduna State, Nigeria. Global Journal of Health Science. 2013; 6(1):142-153.

13. Sabo GK, The Role of Dog Trade in The Epidemiology of Rabies in Plateau State of Nigeria. M.Sc Thesis. Ahmadu Bello University, Zaria, Nigeria. 2009; 13-50.

14. World Health Organisation (WHO) WHO Expert Consultation on Rabies. WHO Technical Report Series. 2005, 931.

15. Wunner WH, The wistar Institute Philadelphia, Academic Press, PA U.S.A Elsevier Inc. Encyclopedia of Microbiology 3rd edition. 2009, 484-499.