Assessment of risk factors associated with epidemiology of *Peste des Petits* ruminants (PPR) in sheep and goats in Abia State, Nigeria.

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ABSTRACT

Peste des Petits Ruminants (PPR) is a highly contagious and trans-boundary disease caused by the PPR virus belonging to the family; Paramyxoviridae and is closely related to the Rinderpest virus of cattle. Its implications on successful small ruminant farming cannot be over-emphasized. Its current status with respect to farmers' awareness and assessment of risk factors associated with the emergence and spread of the disease were investigated. A structured questionnaire-based cross-sectional study was conducted from purposively selected farms on randomly selected local government areas (LGAs) in the three agricultural zones in Abia State. The questionnaires (n=42) were distributed among small ruminant farmers to determine the knowledge, attitude and preventive measures adopted by farmers, with respect to PPR in the study area. Statistical analysis was performed at a 95% confidence level using Statistical Package Social Sciences (SPSS) version 23. The study highlighted high levels (78.6%) of awareness of PPR in the study area. Out of all respondents, 64.3% practiced intensive system of management and 57.1% had observed outbreaks on their farms. About 26.2% noticed the disease especially in young animals, with 64.3% observing these outbreaks at certain season of the year. Quarantine (26.2%) and control of stray sheep/goats (42.9%) were the major preventive measures adopted in the study area. Only a few respondents (33.3%) vaccinated their animals while the majority of respondents (54.7%) never practice vaccination as a preventive measure. There was significant association (p<0.05) between notice of disease, frequency of PPR occurrence, age of animals, seasons of occurrence and PPR outbreak. Limited use of veterinary services, seasons of the year, introduction of new or replacement animals into the flock without quarantine were identified risk factors associated with the emergence, spread and persistence of PPR in Abia State. Consequently, effective control measures such as mass vaccination especially at indicated peak seasons is recommended for the study area. Also, consistent extension programs for all stakeholders in the study area on the importance of PPR and economic benefits associated with curbing PPR in the area are pertinent.

Keywords: Abia, awareness, occurrence, *Peste des petits ruminants*, questionnaire, small ruminants.

INTRODUCTION

Peste des petits ruminants (PPR) is a highly contagious disease of small ruminants, also known as Goat Plague, Kata, Ovine Rinderpest, Pneumoenteritis Complex, Stomatitis-Pneumoenteritis Syndrome (Kumar *et al*., 2014). PPR affects small ruminants of all ages (Chukwudi *et al.,* 2021) and is characterized by pyrexia, sneezing, mucopurulent nasal discharges, ocular discharges, cough, dypsnea, diarrhoea, ulcerative necrotic stomatitis and death (Balamurugan *et al*., 2014). PPR is considered a disease of great economic impact (OIE, 2014). It is a significant threat to a thriving small ruminant production, as it results in huge economic losses to farmers as a result of the high morbidity and mortality rates associated with it. Negative impact of PPR on the livelihood of farmers, especially in Africa where it significantly hinders the growth of small animal farming, makes it a target for eradication (Abu-Elzein *et al.,* 1990).

The disease is caused by a virus, *Peste des petits ruminants* virus (PPRV); an RNA virus and a member of the genus *Morbillivirus* in the Paramyxoviridae family and order Mononegavirales (Maclachlan & Dubovi, 2011; Knipe & Howley, 2013). The virus was first reported in 1942 in Cote d'Ivore during World War II (Gardenne & Lalene, 1942) and has spread rapidly around the globe since then. Availability of epidemiological data is key to control and eradication of any disease. Therefore, studies aimed at determining the

knowledge, attitudes and practices of small ruminant farmers and handlers is crucial because of their roles in the spread of the disease and.an understanding of the factors that promote high incidence of the disease is critical in controlling this disease. This study was therefore carried out to determine and assess the possible factors that promote the spread of *Peste des petits ruminants* (PPR) in a susceptible population of sheep and goats in Abia State.

MATERIALS AND METHODS

STUDY AREA
The study was conducted in Abia State, Nigeria, which is located in the South-Eastern part of Nigeria (latitudes 5°25' North of the equator and longitudes 7°30' East). Abia state is located in the rainforest savannah zone of Nigeria and agriculture is the major occupation of people living in the State. It employs over 70% of the population thus, contributing massively to the economy of the state. A good percentage of the populace is engaged in animal husbandry. There are three agricultural zones in Abia State; Umuahia, Aba and Ohafia agricultural zones ((Njoku *et al.,* 2013).

STUDY DESIGN AND POPULATION
Protocol for this study was reviewed and approved by the Institutional Animal Care and Use Committee (IACUC) of the Faculty of Veterinary medicine, University of Nigeria, Nsukka with Reference number: FVM-UNN-IACUC-2023-90/120.

A structured questionnaire was developed and validated in order to meet the objective of this study. Two local government areas were randomly selected from each agricultural zone in the state and by purposive sampling; farms in the study area where questionnaires were administered were selected. Questionnaires were distributed evenly across the selected local government areas /zones. In-person interview of the structured questionnaires was employed for illiterate participants while it was distributed contemporarily to others.

QUESTIONNAIRE, PRE-TESTING, AND CONSENT
The pre-test of the questionnaire was done among a randomly-selected small group of livestock traders/farmers (n =10) to verify the applicability and clarity of the questionnaires, and the time needed for each interview. A total of 42 questionnaires were distributed to farmers, farm attendants and farm managers. The questionnaire was structured into four distinct sections. The first section was on demographic information such as age, sex, educational and employment status of respondents. The second section was on husbandry practices engaged by farmers in the area. The third section was on disease information including questions on occurrence of outbreaks of PPR, clinical signs observed and frequency of outbreaks, patterns of outbreaks at particular seasons of the year (using a 3-point likert scale). The fourth section accessed approaches adopted by farmers, such as vaccinations and quarantine towards prevention of PPR in the study area. A total of 14 risk factors were assessed to determine their association with PPR occurrence in sheep and goats in Abia State. The risk factors accessed include: Locality, husbandry information, flock size, management system, housing, source of animal, quarantine practice, feeding patterns, frequency of outbreaks, season, age, sex, and veterinary interventions.

DATA ANALYSIS
Descriptive and inferential statistics were used in this study to analyse data from questionnaires. Descriptive statistics was carried out using Microsoft Excel 2007. Chi-square Test of independence and odds ratio (OR) were used to determine the association of the investigated risk factors and PPR positive and negative cases (as suggested from the information provided by the respondents. A binary logistic regression model was then used to determine the strength of the association between the variables with regards to PPR occurrence. Statistical significance was set at a probability level of $p \leq 0.05$. Data were analysed by Statistical Package for the Social Sciences (SPSS) software (version 23.0).

RESULT
Out of the 42 respondents, most (73.8%) were males and within 18–30 years (57.1%). The degree of literacy varied amongst the respondents, with only 42.9% having secondary education as their highest level of education, while 35.7% had tertiary education. About 45.2% were married. Majority of respondents (36.4%) kept both sheep and goats but 21.1% of farmers in the study area raised and sold not only small ruminants, but also other species of animals in their farms while only 19.0% were strictly small ruminant farmers. Age, gender, educational status, and occupation were significantly associated ($p<0.05$) with PPR outbreaks.

About 45.2% of the respondents were married and 35.7% had tertiary education and 19.0% were strictly small ruminant farmers. Age, gender, educational status, and occupation were significantly associated ($p<0.05$) with PPR outbreaks.

HUSBANDRY INFORMATION
Majority of the respondents operated the intensive range system (72.7%), introduced new animals into their flock often times for various reasons, such as replacement, breeding, or as gifted animals and so, without quarantine (73.8%). Majority (71.2%) of the respondents sourced their new animals from reliable farms, but 24% of them got their animals from the livestock markets, while 4.8% of respondents could not establish source of new animals. There was significant association ($P<0.05$) between husbandry

system practiced, source of animals introduced into the flock, practice of quarantine and PPR outbreak (Table I).

Table I: Association of husbandry information and PPR outbreak=

PPR outbreak

Variable	No	Yes	χ^2 value	Df	p-value
Type of animals kept					
Goat	3 (33.3)	10 (30.3)			
Sheep	0 (0.0)	4 (12.2)	2.134	3	0.545
Both	5 (55.6)	12 (36.4)			
Kept with other animals	1 (11.1)	7 (21.1)			
Management system					
Free range	6 (66.7)	9 (27.3)			
Intensive	3 (33.3)	24 (72.7)	4.780*	1	0.029
Flock size					
1-10	7 (77.8)	12 (36.4)			
11-20	0 (0.0)	9 (27.3)	5.560	2	0.062
> 20	2 (22.2)	12 (36.4)			
Introduce					
No	2 (22.2)	7 (21.2)	0.004	1	0.948
Yes	7 (77.8)	26 (78.8)			
Often					
None	2 (22.2)	2 (6.1)			
Rarely	3 (33.3)	17 (51.5)	4.468	4	0.346
Often	4 (44.4)	9 (27.3)			
Very often	0 (0.0)	2 (6.1)			
Always	0 (0.0)	3 (9.1)			
Source					
None	2 (22.2)	0 (0.0)			
Market	2 (22.2)	8 (24.2)	7.749*	2	0.021
Reliable farms	5 (55.6)				
Quarantine after contact					
No	9 (100.0)	22 (66.7)	4.065*	1	0.044
Yes	0 (0.0)	11 (33.3)			

DISEASE INFORMATION

Regarding PPR, majority of the farmers (78.6%) indicated awareness of the disease through knowledge of its clinical signs such as nasal discharges, cough and diarrhoea with heavy morbidity and mortalities. 57.1% of respondents indicated they had noticed PPR clinical signs on their farms but only 26.2% of them often experienced PPR outbreaks. A total of 33.3% respondents indicated they lost more than half of their flocks during outbreaks, 11.9% of respondents lost all their animals during an outbreak but 23.8% of

respondents lost no animals during PPR outbreaks. Also, 64.3% of respondents acknowledged that PPR outbreaks were noticed more with younger animals and at certain seasons of the year, especially the dry seasons. There was significant association (P<0.05) between notice of disease, frequency of PPR occurrence, age of animals, seasons of occurrence and outbreak of PPR (Table II). Table III reports the findings from binary logistic regression predicting the factors associated with PPR outbreaks amongst study objects. It shows that PPR outbreaks were more likely to occur in farms where disease signs were noticed (OR=18.400, 95% CI 2.02-167.30), in young animals (OR=17.500, 95% CI 1.59-191.89), even though much more likely to occur in all ages of animals (OR=28.000, 95% CI 2.63-297.87) and during rainy seasons (OR=16.800, 95% CI 1.60-176.23).

Binary logistics regression analysis demonstrated that animals raised on free range or semi-intensive management system (OR=1.833, 95% CI 0.57-5.93) and without quarantine practice (OR=1.500, 95% CI 1.18-1.91) were more likely to have PPR outbreaks compared to their counterparts. It also showed that PPR outbreaks were more likely to occur in farms/farmers where disease signs were noticed (OR=18.400, 95% CI 2.02-167.30), in young animals (OR=17.500, 95% CI 1.59-191.89) and during rainy seasons (OR=16.800, 95% CI 1.60-176.23) (Table IV)

PREVENTIVE MEASURES ADOPTED BY FARMERS IN THE STUDY AREA

From the survey, respondents adopted different approaches in preventing outbreaks of PPR among their flocks. Only 11.87% always vaccinated their animals while 54.76 % never vaccinated their animals against PPR. Some of the respondents (42.86%) prevented PPR outbreaks through control of their flocks from stray sheep and goats and only 26.19% quarantined their animals. On the other hand, 33.3% of respondents never controlled stray animals and 47.62% never quarantined new or sick animals. (Table IV)

PPR outbreak

Table II: Association of disease information and PPR

Variable	No	Yes	χ^2 value	Df	p-value
Notice					
No	8 (44.4)	10 (55.6)	9.911*	1	0.002
Yes	1 (4.2)	23 (95.8)			
Frequency					
None	7 (63.6)	4 (36.4)			
Rarely	2 (11.1)	16 (88.9)	16.323*	4	0.001
Often	0 (0.0)	11 (100.0)			
Very Often	0 (0.0)	2 (100.0)			
Frequency of occurrence					
None	7 (77.8)	2 (22.2)			
Rarely	2 (9.l)	20 (90.9)	21.962*	2	0.000
Often	0 (0.0)	11 (100.0)			
Observe					
None	8 (66.7)	4 (33.3)			
All the time	0 (0.0)	3 (100.0)	20.442*	2	0.000
At particular time of the year	1 (3.7)	26(96.3)			
Season					
No season	6 (54.5)	5 (45.5)			
March-May	1 (6.7)	14 (93.3)			
June-Sept	2 (25.0)	6 (75.0)	11.349*	4	0.023
Oct-Nov	0 (0.0)	2 (100.0)			
Dec-Feb	0 (0.0)	6 (100.0)			
Ages					
None	7 (63.6)	4 (36.4)			
Young animal	1 (9.1)	10 (90.9)	15.892*	4	0.003
Growers	0 (0.0)	1 (100.0)			
Adult Animal	0 (0.0)	2 (100.0)			
All Ages	1 (5.9)	16 (94.1)			
Sex suffer					
Female	3 (37.5)	5 (62.5)	1.516	1	0.218
Both	6 (17.6)	28 (82.4)			

DISCUSSION

PPR has been regarded as a huge hindrance to livestock production due to the associated huge economic losses (Shamaki *et al.*, 2004). The World Health Organization (WHO) has designated the year 2030 as the year for eradicating *Peste des Petits Ruminants* (PPR) (OIE, 2014); sero-surveillance and assessment of risk factors are vital steps towards PPR eradication.

Analysis of the information from the respondents showed that most of the farmers that own sheep and goats in the area are males. This suggests male domination in small ruminant farming in the study area. This may be because of the relatively higher economic value from small ruminant than village poultry farming where women and children have been reported to dominate (Aleme & Mitiku, 2015). Men may prefer sheep and goat farming so as to raise more meaningful income for family needs. Goat rearing was also observed to be preferred in the area as most of the small ruminant farmers in the area keep goats while a smaller number combine sheep and goats. This may be attributed to high demand for goats than sheep in the area, possibly for meat, as gifts and for ceremonies. It has been noted that goat are more susceptible to PPR and this greater number of goats may play a role in the epidemiology of the disease in the area. Most farmers engaged the intensive system of management. The intensive system of management is a good strategy in the prevention of spread of infection, but when there are no biosecurity measures put in place, then keeping all ages of animals together in the same pen most of the time can lead to the spread of disease to the most vulnerable age group, rather than prevent it. Majority of the farmers get their animals from reliable farms, most of these newly acquired animals are not quarantined before introduction into the flock. This could be a major source of introduction of PPRV into a flock. Because the farmers are careful when sourcing their stock coupled with the fact that they restrain their animals from mixing up with other people's animals implies that they are aware of the infectious nature of diseases especially PPR.

On the respondent's information on disease outbreaks in their flocks, analysis showed that most of the farmers have had disease outbreaks in their flocks. The disease outbreaks were occasional with the sign that are typically associated with PPR being familiar to the farmers. The farmers associated the disease with the dry seasons, with most of the farmers believing that PPR is common from December to May which harbours the peak of the dry season. This period is characterized by dry and dusty weather, which ultimately favours the spread of the disease. This agrees with the reports of Ezeibe *et al.* (2008).

Though the farmers believed that the infection could be acquired through unknown sources, they are aware that introduction of a new animal into a flock and mixing of

animals like during sales in the market, during lending for mating and the release of animals during the dry season when there are scarcity of pasture (Nizamani *et al.,* 2015) could lead to outbreak and spread of infection. Farmers

]lTable III: Effect of disease information and PPR outbreak in Abia State (Binary Logistics Analysis)

| Variables | Occurrence of PPR | | | | |
	No (%)	Yes (%)	Odd ratio	95% CI	p-value
Notice					
No	8 (44.4)	10 (55.6)	RF	2.02-167.30	0.002
Yes	1 (4.2)	23 (95.8)	18.400		
Ages					
None	7 (63.6)	4 (36.4)	RF		
Young animal	1 (9.1)	10 (90.9)	17.500	1.59-191.89	0.019
All Ages	1 (5.9)	16 (94.1)	28.000	2.63-297.87	0.006
Season					
No season	6 (54.5)	5 (45.5)	RF		
March-May	1 (6.7)	14 (93.3)	16.800	1.60-176.23	0.019
June-Sept	2 (25.0)	6 (75.0)	3.600	0.49-26.40	0.208

TABLE IV: Information on the preventive measures used against PPR in small ruminants in Abia state

Variable	Frequency	Percentage (%)
VACCINATION		
Not Used	23	54.8
Used Sometimes	14	33.3
Used Often	5	11.9
CONTROL OF STRAY ANIMALS		
Not used	14	33.3
Used Sometimes	10	23.8
Used Often	18	42.9
QUARANTINE AND BIOSECURITY PRACTICES		
Not Used	20	47.6
Used Sometimes	11	26.2
Used Often	11	26.2

believed that PPR is common among all age groups of animals while most are of the opinion that PPR is more prevalent and severe in the young. A few respondents are of the opinion that PPR is more prevalent in the females than the males but most did not associate PPR with any particular sex of small ruminants. This fact is difficult to ascertain accurately here since the farmers keep mostly the female animals for breeding. A holistic assessment of the information by the farmers showed that the farmers were able to identify risk factors that are involved in disease outbreak. The risk factors identified in this study include extensive production systems, housing animals of different ages, introduction of new animals, no quarantine before introduction, season of the year and age, limited use of veterinary services by farmers are important factors that have also been reported (Abubakar *et al*., 2009; Chukwudi *et al*., 2020).

In a similar study carried out across three of the South Eastern States, key risk factors such as lack of awareness of PPR vaccination among small ruminant farmers, seasonality and introduction of animals into the flock without quarantine and limited use of veterinary services by farmers were identified (Chukwudi *et al*., 2020).

The major preventive measure adopted by most of the farmers in the study area is control of stray sheep and goats. Most respondents did not vaccinate their animals in the area. This implies possible continuous endemicity of PPR in an affected area. This could be due to lack of awareness of PPR vaccination or due to unavailability of vaccines in the area, or unwillingness to engage veterinary interventions on the part of the farmers. Chukwudi *et al*., (2021) observed that the homologous PPR vaccine was unavailable at various veterinary establishments/outlets in some states in the South-Eastern part of Nigeria was attributable to expiration of stored vaccines due to lack of demand and in-adequate power supply to maintain the cold chain of the vaccines.

CONCLUSION

The information obtained from the risk assessment questionnaires reiterates the endemic nature and importance of the disease in small ruminants in Abia State, Nigeria.

Many risk factors which are important in the epidemiology of the disease encourage the emergence, spread and persistence of the disease amongst small ruminant population in the state. The identified risk factors associated with the disease in the area include age of the animal, species of the animal, sex of the animal, housing system, introduction of new animals without quarantine, season or period of the year and limited use of veterinary services.

There should be coordinated government involvement in the control of the disease by controlling animal movements within and outside the state or nation, mass vaccination of small ruminants targeting the seasons when the disease is prevalent coupled with regular sero-monitoring program to give a better indication of herd immunity.

CONFLICT OF INTEREST
There are no conflicts of interest

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