

A ten-year retrospective study of Peste des petits Ruminantis (PPR) cases presented to the National Veterinary Research Institute, Vom Plateau State, Nigeria

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ABSTRACT: Peste des petits ruminantis (PPR) is a severe, highly contagious disease of small ruminants, primarily sheep and goats caused by Peste des petits ruminant's virus (PPRV). It is an important animal disease which now endangers the large populations of small ruminants in Africa, the Middle and Near East, Southwest and Central Asia. PPR is an important transboundary disease of small ruminants throughout Nigeria, it plays an important role in agricultural food production and in sustainable employment. This vaccine strain currently used for the control of PPR in Nigeria is revealed to be indeed the suitable one for use in Nigeria. A retrospective study was carried out to determine the epidemiology and distribution of PPR across Nigeria by looking at the seasonal trend of the disease between 2013-2022. All data on animal carcasses, blood/serum, and tissue samples suspected of PPR from 2013 to 2022 were retrieved from the archival records of the Central Diagnostic Division of NVRI, Vom, Nigeria. The date, location, species, sex, age, flock size, animals affected, mortality and test result were extracted and entered in an Excel file to generate frequency tables. From the year 2013 to 2022, a total of 600 PPR suspected cases were reported to NVRI Vom, out of which 206(34%) tested positive for PPRV. The result shows that the highest occurrence of PPR 55 (26.7) was recorded in the year 2022 and the least occurrence of 4(1.9) was recorded in the year 2018. The number of small ruminants affected within the period under review is around 15,623 while the mortality is around 3574 (22.9%). About 51.4% (109) was reported in Ovine while the remaining 48.6% (103) was in Caprine. A prevalence rate of 34% was reported in this study. This study further confirms the devastating effect of PPR disease, affecting sheep and goats, males and females of all ages. The results highlight the need to monitor the occurrence of PPR and to adopt a strategic vaccination campaign against PPR.

Keywords: Nigeria, Peste des petits ruminantis, Plateau State, retrospective study.

INTRODUCTION

In Nigeria, sheep and goats are widespread, across different ecological and climatic zones of the country, with a population of approximately 73.8 million goats and 42.1 million sheep (Mantip *et al.*, 2016; Nnabuife *et al.*, 2023). Small ruminants play a very important role in Nigeria's livestock production system, helping to meet the rising demand for animal protein in Nigeria's population of over 225 million people (World Population Review of 2023) contributing manure for crop production, the skins support

the leather industry and earn foreign exchange, and they are the only food and cash security available to many Nigerians in the rural communities (Obi *et al.*, 1988; Woma *et al.*, 2015). Increased mortality in the small ruminant population has been attributed to diseases, with PPRV infection being among them (El-Yuguda *et al.*, 2010; Woma *et al.*, 2016). Peste des petits ruminants (PPR) is a major cause of death among small ruminants in Nigeria (Woma *et al.*, 2016). It has been identified by the

International Livestock Research Institute (ILRI), Nairobi, Kenya as one of the priority animal diseases (Kumar *et al.*, 2014). It has become a major threat to small ruminant existence and food security in Africa and neighbouring continents (Balogun *et al.*, 2017; Jones *et al.*, 2020).

Peste des petits ruminantis is a highly contagious animal disease caused by PPRV, which is classified in the genus *Morbillivirus* within the family *Paramyxoviridae*, order *Mononegavirales*. It is closely related to the rinderpest virus (RPV), canine distemper virus (CDV), measles virus (MV) and cetacean morbilliviruses (Munir, 2013). It is the cause of a highly contagious viral disease in domestic and wild ruminants of all ages (Mantip *et al.*, 2019; Balamurugan, 2014). The official name of this virus was changed in 2016 to Small Ruminant Morbillivirus (Amarasinghe *et al.*, 2017). It is a severe, fast-spreading viral disease of domestic small ruminants, primarily sheep and goats. This disease is referred to as Stomatitis pneumoenteritis complex (SPC), Pseudorinderpest and Kata. In Some geographical regions across the world, PPR virus infection is identified under other synonyms such as syndrome of stomatitis-pneumoenteritis, ovine rinderpest, goat plague, plague of small ruminants, etc. (Mulumba-Mfummu, *et al.*, 2021; OIE, 2020; FAO and OIE, 2015). PPR is also believed to be a seasonal disease occurring mostly during the dry season in most endemic areas of Africa (Lancelot *et al.*, 2002; Abubakar *et al.*, 2009). It is an important animal disease which now endangers the large populations of small ruminants in Africa, the Middle and Near East, Southwest and Central Asia (Bedore *et al.*, 2019). PPR field outbreaks were recorded in sheep and goats across different ecological zones in most states of Nigeria, it remains an endemic disease in the country, accompanied by sporadic epidemics (Kazeem *et al.*, 2009; Mantip *et al.*, 2019). Animal migration contributes to the spread of Peste des petits ruminants (PPR) disease, thus having a major impact on the livelihood of sheep and goat farmers across Africa, the Middle East and Asia (Bataille *et al.*, 2021). A study conducted between 1995 and 2002 reported the PPR seroprevalence rate in some states of Nigeria at 49% in sheep and 38% in goats (Shamaki, 2002) while a study conducted across all regions in Nigeria between 2010 to 2015 reported a seroprevalence rate of 23% (Woma *et al.*, 2016). Peste des petits ruminants also affect wildlife both under field conditions and experimentally. Antelope and other small wild ruminant species can also be severely affected. A case of clinical disease has been reported in wildlife resulting in the deaths of gazelles (*Gazella dorcus*), ibex (*Capra ibex nubiana*), gemsbok (*Oryx gazelle*) and Laristan sheep (*Ovis orientalis laristanica*) (Elzein *et al.*, 2004). The American white-tailed deer (*Odocoileus virginianus*) can be infected experimentally with PPRV (Hamdy *et al.*, 1976). A seroprevalence of up to 10% has been reported in camels with natural transmission of PPRV under field conditions in Ethiopia (Abraham *et al.*, 2006). Experimental infection of camels in Saudi Arabia with PPR

virus resulted in only subclinical infection or mild respiratory disease; infection was transmitted to other camels and goats but not to sheep (Abd El-Hakim, 2006). Clinical PPR cases in camels have been reported in Kassala state, Eastern Sudan (Khalafalla *et al.*, 2010). It is generally admitted that cattle can only be infected sub-clinically, no natural outbreak has been reported in cattle. Pigs can be sub-clinically infected with PPRV, but they do not transmit the virus and therefore are not considered to be important in the epidemiology of PPR (Nawathe and Taylor, 1979).

PPR virus is readily and rapidly inactivated in external conditions and dead animals respectively, as such transmission from infected animals to susceptible ones is by close contact through oral, nasal, and ocular excretions (Couacy-Hymann *et al.*, 2007). It leads to variable clinical disease outcomes, causing only mild disease within some populations and often associated with explosive outbreaks of severe disease, causing high morbidity and mortality rates during epizootics (FAO 2009, Mahapatra *et al.*, 2021). The characteristic clinical signs begin with a sudden rise in body temperature, followed by signs of pneumonia. With the onset of fever, the animals suffer loss of appetite and become severely depressed. Sick animals develop nasal discharges that are initially clear but later become grey and sticky due to secondary bacterial infection. These discharges may remain mild or may progress to severe inflammation of the mucous membrane of the nose that is characterized by the presence of exudates that crust and block the nostrils and cause respiratory distress. Severely affected cases show difficult and noisy breathing marked by the extension of the head and neck, dilation of the nostrils, protrusion of the tongue and soft painful coughs (Anna and Roth, 2006). Severely affected animals develop profuse, non-hemorrhagic diarrhoea resulting in severe dehydration, which may progress to emaciation with sunken eyeballs and death within 5-10 days. Other animals may recover after a protracted convalescence. The more severe form of the disease results from mixed infections of bacteria and viruses rather than by single infection (Mann *et al.*, 1974; Saliki, 1998).

The diagnosis of PPR virus infections may be achieved by a combination of clinical signs and epidemiology, gross and microscopic pathological lesions, virus isolation and characterization and serological tests designed to detect virus antigen or antibody (Mantip *et al.*, 2019). Recently, molecular biology tools have made it possible to diagnose this disease rapidly and with great sensitivity compared to earlier tests (Luka *et al.*, 2011).

There is no specific treatment against PPR. Control of the disease in previously non-infected countries can be effected through strict quarantine, movement controls, restriction of importation of sheep and goats from affected areas, rapid identification and humane slaughter. In areas where PPR is endemic, the commonly employed control mechanism is vaccination (OIE, 2009). A live attenuated culture vaccine based on Nigeria 75/1 strain is widely used

for vaccination and immunization in almost all the PPR endemic areas of the world. This vaccine is safe for pregnant dams and induces immunity in at least 98% of the vaccinated animals in the field (UNFCCC, 2020). This vaccine strain currently used for the control of PPR in Nigeria is revealed to be indeed the suitable one for use in Nigeria.

The adverse consequences posed by PPR disease in small ruminants in Nigeria are enormous (FAO, 2018). The epidemiology of PPR in Nigeria has not been fully made clear, and it is possible that it occurs in a more diverse range of hosts (Balogun *et al.*, 2017; Jones *et al.*, 2020). Inadequate documented information and comprehensive data on the current trend accompanying outbreaks of PPR in Nigeria deserve a thorough investigation and attention. Hamdy *et al.* (1976) evaluated the annual loss incurred by PPR in Nigeria at US\$ 1.5 million, equivalent to approximately US\$ 250 million in the current economy. The control and eradication of PPR is a priority and has recently become a target for global eradication by the international animal health community. PPR has remained the major threat for small ruminant farmers, making a significant impact on food security, livelihoods, and trade, thus a subject of worldwide eradication campaigns (FAO, 2015; UNFCCC, 2020). Understanding the epidemiology of the disease is of significance to help draw the attention of policy makers to the need to support the 2030 date of the PPR global eradication program. The study aims to make available data and information for improved surveillance and control of PPR in Nigeria. The specific objectives of the study are to look at the epidemiology and distribution of PPR across Nigeria to estimate the yearly magnitude of reported cases, and to look at the seasonal trend of the disease between 2013-2022.

MATERIALS AND METHODS

Study area

This study was carried out at the National Veterinary Research Institute (NVRI), Vom, Jos South LGA, Plateau State, Nigeria. Plateau state is located between latitudes 8° and 10° north and longitudes 7° and 11° east. The state is bordered to the east by Bauchi State, to the Northeast by Taraba State, to the south by Nasarawa State, and to the north by Kaduna State (National Agricultural Sample Survey, NASS, 2011). It is a reference laboratory for the diagnosis of Peste des petits ruminants in Nigeria. The Veterinary Pathology Division - Central Diagnostic Laboratory of the NVRI Vom receive sample from all over the country for confirmatory diagnosis of Peste des petits ruminants. Samples obtained from animals showing clinical signs compatible with PPR were presented. Various techniques were used for confirmation depending on the nature of the samples presented and the prevailing circumstances. The laboratory tests currently used for PPR diagnosis in the Central Diagnostics Laboratory and

PPR lab, Viral Research NVRI, Vom include a combination of either of the following; Necropsy examination for gross and Histopathological changes; Competitive ELISA or Immune capture ELISA; Reversed Transcription Polymerase Chain Reaction (RT-PCR); Isolation of PPR virus in cultured cells.

There is a full-fledged functional department at the NVRI for quality assurance and quality control. The mandate of this department is to ensure that all diagnostic processes in the Institute conform to Standard Operating Procedures and international best practices.

Data collection

All data on animal carcasses, blood/serum, and tissue samples suspected of PPR from 2013 to 2022 were retrieved from the archival records of the Central Diagnostic Division of NVRI, Vom, Nigeria. The date, location, species, sex, age, flock size, animals affected, mortality and test result were extracted and entered in an Excel file to generate frequency tables.

Data analyses

Using Microsoft Excel version 2016, data collected were compiled, processed, and analyzed using descriptive statistics, and results were presented in tables, charts and graphs.

RESULTS AND DISCUSSION

The number of animals (small ruminants) affected within the period under review is around 15,623 while the mortality recorded is around 3574 (22.9%). The number of cases reported in Ovine species is around 109 (51.4%) and in Caprine species 103 (48.6%). The number of females affected is 150 (52.6%) while males infected with PPR totals 135 (47.4%). About 101 (48%) of the affected population are adults (10 months and above), while 62 (29%) are young (0-9 months). About 106 (51.5%) samples were only tested for PPR infection while 100 (48.5%) samples were diagnosed holistically for other concurrent infections as shown below:

- 67 cases (32.5%) had bacterial infection: *E. coli* (26), *Staphylococcus* (11), *Bacillus* (6), *Klebsiella* (6), *Proteus* (4), *Pseudomonas* (3), *Enterobacter* (4), and *Mycoplasma* (9).
- 35 cases (17%) had Hemoparasite: Piroplasmosis/Babesia.
- 13 cases (6.3%) had Ectoparasites: Ticks
- 28 cases (13.6%) had coccidiosis.
- 37 cases (18%) had worms: Helminthes/Cysticercosis
- 9 cases (4.4%) had Bloat/Rumen impact/Traumatic injury/Management.

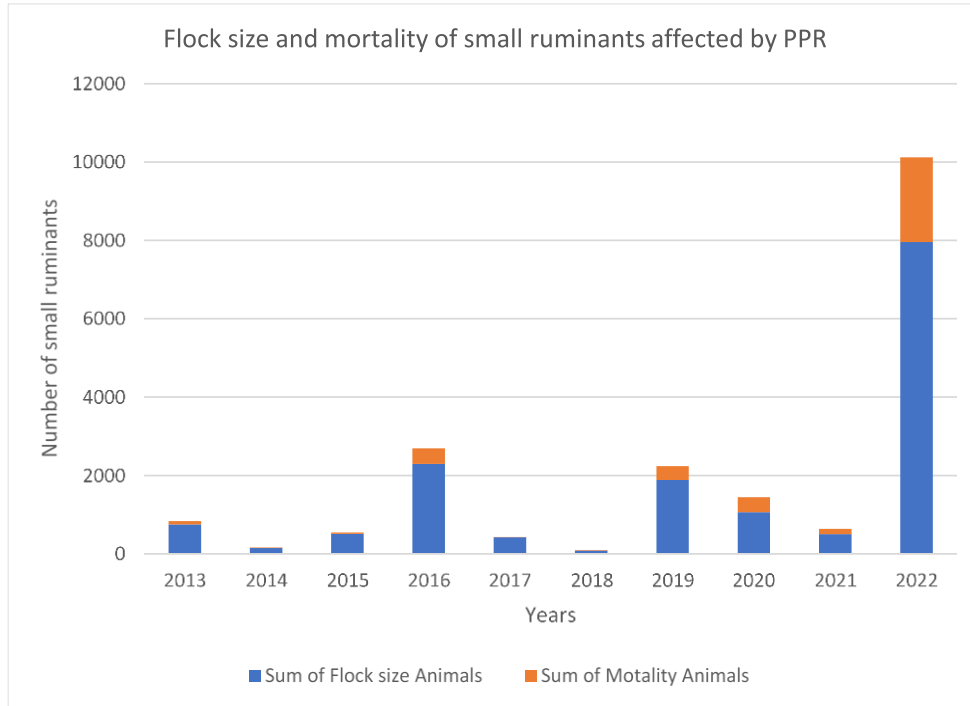


Figure 1. A stacked column showing the distribution of Flock size and mortality of animals affected by Peste des petits Ruminantis disease reported in National Veterinary Research Institute, Vom (2013-2022).

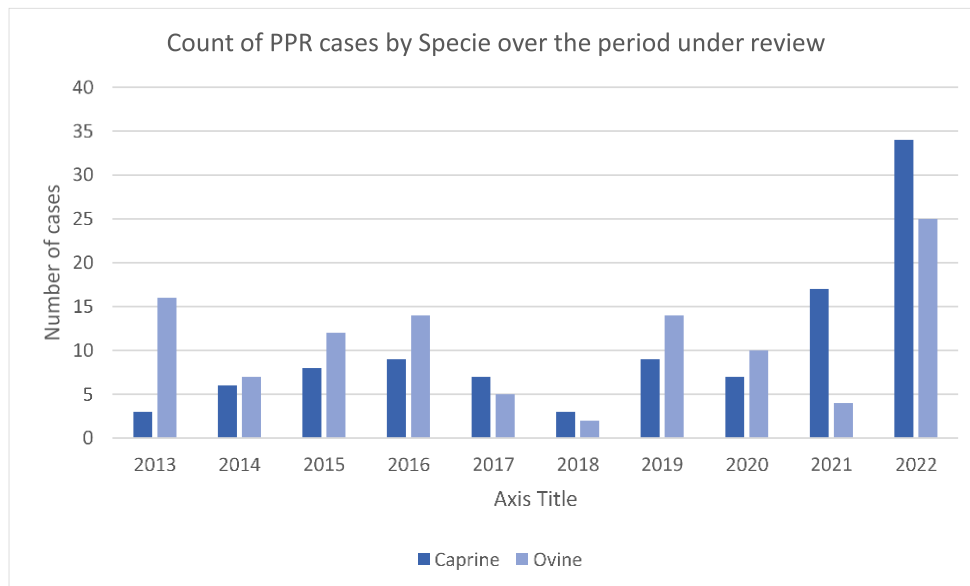


Figure 2. A bar chart showing species distribution of Peste des petits Ruminantis disease cases reported in National Veterinary Research Institute, Vom (2013-2022).

Findings from the records available show the occurrence of Peste des petits ruminants (PPR) field outbreaks in sheep (51.4%) and goats (48.6%) (Figures 1 and 2) across 22 states of Nigeria and FCT (Figure 3). This agrees with earlier studies by Shamaki (2002) and Kazeem *et al.*

(2009) who reported PPR in sheep and goats across different ecological zones in most states of Nigeria and suggested that PPR remains an endemic disease in the country, accompanied by sporadic epidemics (Kazeem *et al.*, 2009; Shamaki, 2002; Kassim *et al.*, 2016). The records

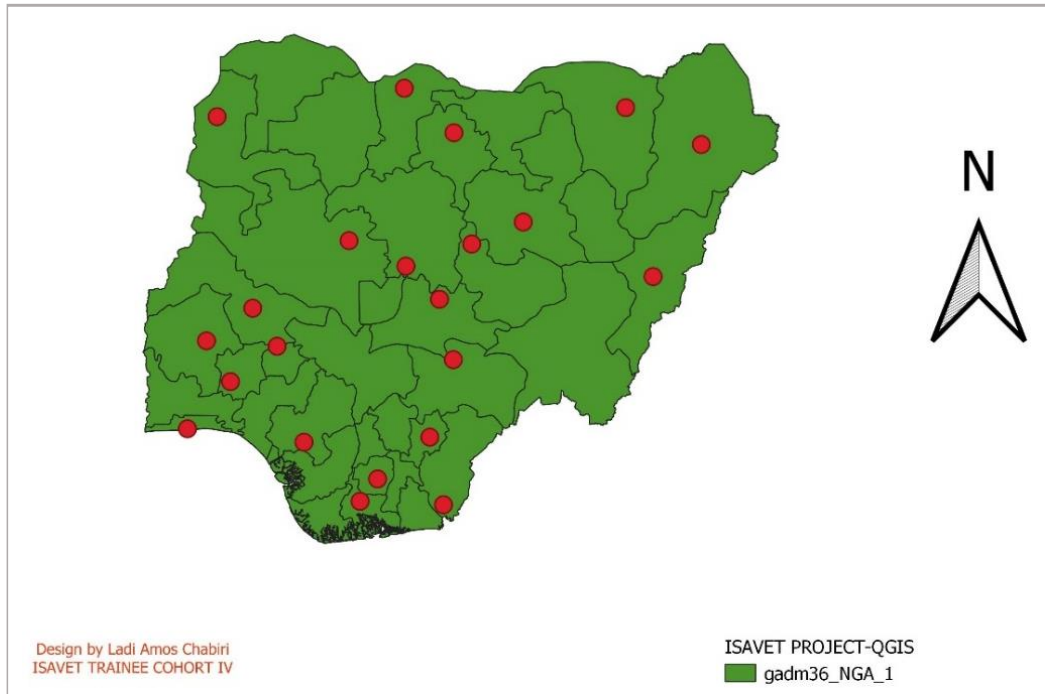


Figure 3. A map showing the distribution of Peste des petits Ruminantis disease cases by state reported in the National Veterinary Research Institute, Vom over a period of 10 years (2013-2022).

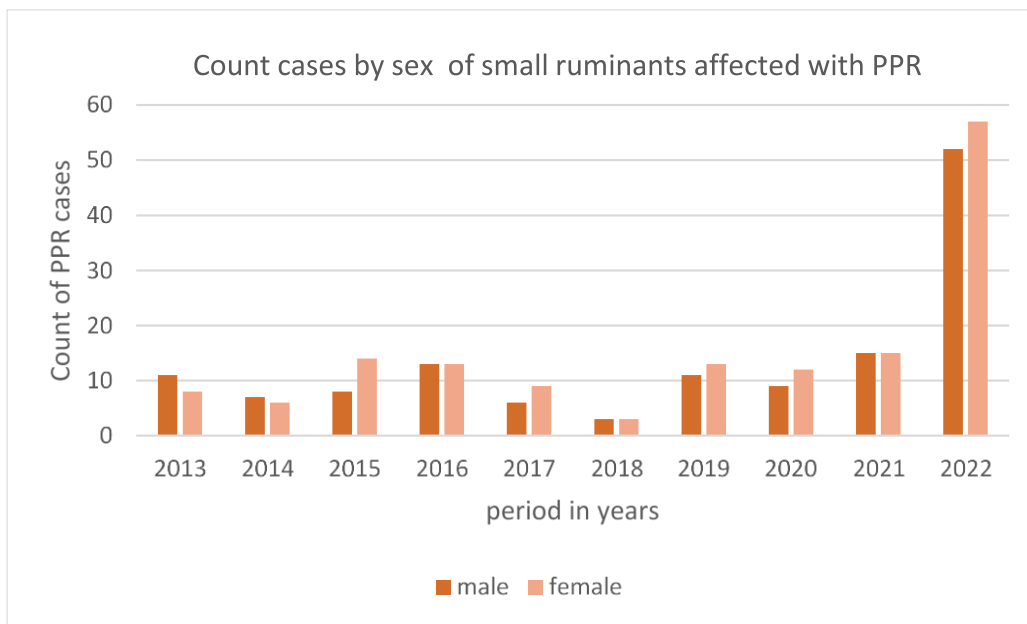


Figure 4. A bar chart showing the sex distribution of Peste des petits Ruminantis disease cases reported in National Veterinary Research Institute, Vom (2013-2022).

show no significant species difference, as Ovine cases recorded 109 (51.4%) as against 103 (48.6%) Caprine, and Sex as well is less likely a factor (Figure 4), which shows females have 150 (52.6%) cases, while 135 (47.4%) cases are reported in males. This is consistent

with the report of Woma *et al.*, (2016) that states that in clean flocks, sheep and goats of all ages can be affected during an outbreak, this impact negatively on the livelihoods, food security and socio-economic activities of livestock keepers in affected areas. Figure 5 is a line graph

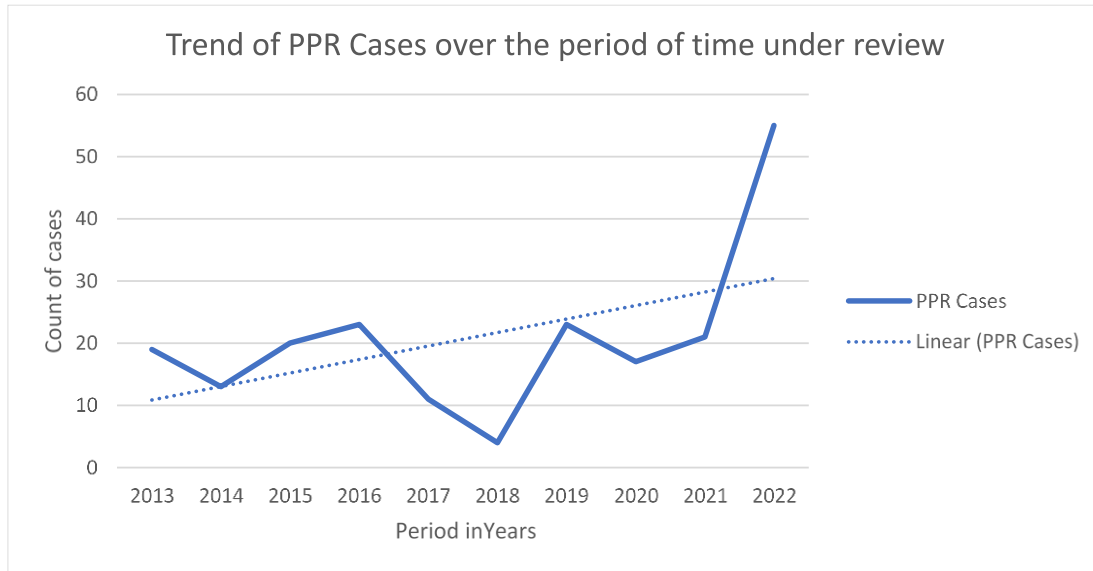


Figure 5. A line graph showing the trend of Peste des petits Ruminantis disease cases reported in National Veterinary Research Institute, Vom over 10 year period (2013-2022).

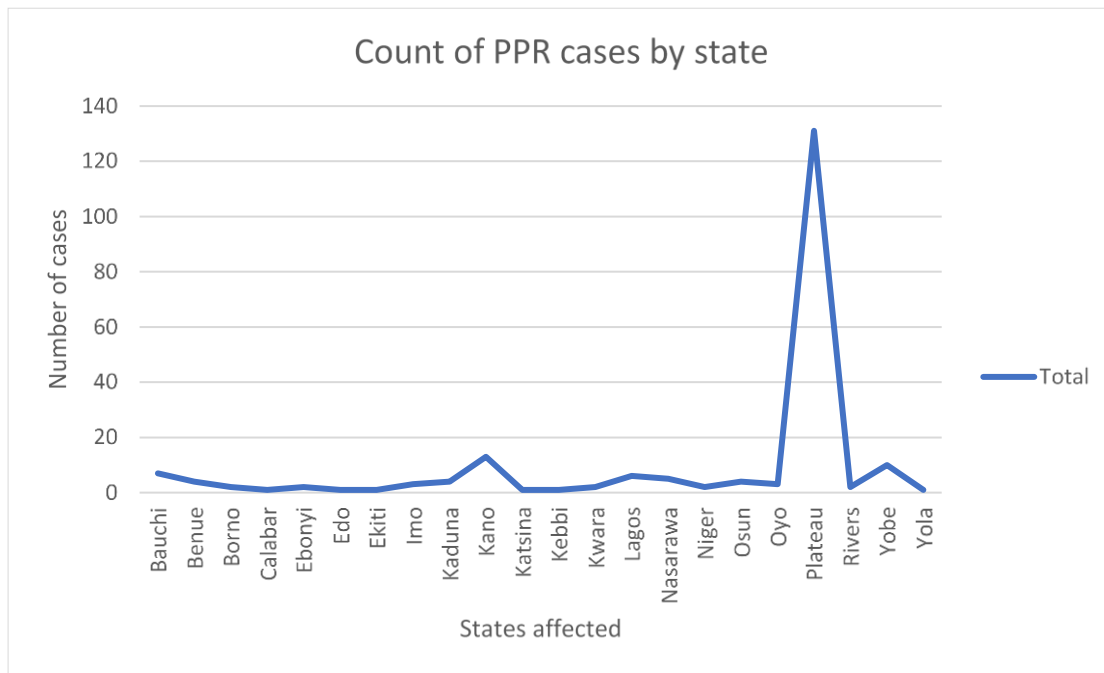


Figure 6. A line graph showing the magnitude of Peste des petits Ruminantis disease cases by state reported in the National Veterinary Research Institute, Vom over a period of 10 years (2013-2022).

showing the trend of Peste des petits Ruminantis disease cases reported in National Veterinary Research Institute, Vom over 10 year period (2013-2022) with undulating frequencies over the years, but peaking in the year 2022. The epidemiology of PPR in Nigeria has not been fully made clear (Jones et al., 2020).

In the current studies, reports show Plateau State having

the highest number of recorded cases, followed by Kano State and Yobe State (Figure 6), which incidentally is among the first two locations PPR was reported in Nigeria (Luka *et al.*, 2011). This may be due to the proximity of the research institute to the area or increased awareness of the disease condition in small ruminants as compared to other locations. It is still not clear whether the apparent

Table 1. Yearly distribution of Peste des petits Ruminantis disease cases reported in National Veterinary Research Institute, Vom (2013-2022).

Year	PPR case (%)	Total cases (%)	Prevalence rate (%)
2013	19(9.2)	54(9)	35%
2014	13(6.3)	32(5.3)	41%
2015	20(9.7)	49(8.2)	41%
2016	23(11.2)	58(9.7)	40%
2017	11(5.3)	56(9.3)	20%
2018	4(1.9)	30(5)	13%
2019	23 (11.2)	53(8.8)	43%
2020	17(8.3)	51(8.5)	33%
2021	21(10.2)	89(14.8)	24%
2022	55 (26.7)	128(21.3)	43%
Total	206(100)	600(100)	34%

The result shows that the highest occurrence of PPR 55 (26.7%) was recorded in the year 2022 and the least occurrence of 4 (1.9%) was recorded in the year 2018.

Table 2. Monthly distribution of Peste des petits Ruminantis disease cases reported in National Veterinary Research Institute, Vom (2013-2022).

Month	PPR case (%)	Total cases (%)	Prevalence rate (%)
January	7 (3.4)	34 (5.7)	3.0
February	10 (4.9)	29 (4.8)	5.0
March	20 (9.7)	53 (8.8)	10.0
April	18 (8.7)	42 (7.0)	9.0
May	9 (4.4)	35(4.5)	4.0
June	27 (13.1)	60 (10.0)	13.0
July	17 (8.3)	69 (11.5)	8.0
August	21(10.2)	69 (11.5)	10.0
September	31(15.0)	78 (13.0)	15.0
October	16(7.8)	52 (8.7)	8.0
November	10 (4.9)	43 (7.2)	5.0
December	20 (9.7)	36(6.0)	10.0
Total	206 (100)	600 (100)	34.0

The result shows that the highest occurrence of PPR cases 31(15.0%) was in the month of September and the least occurrence 7(3.4%) was recorded in the month of January.

geographical spread of the disease in the last two decades is real or just a reflection of increased awareness, wider availability of diagnostic tools or even a change in the virulence of the virus. It seems most likely that combinations of these factors are responsible for the present knowledge of disease distribution.

The result also shows that the highest occurrence of PPR cases 69 (33.5%) was during the rainy season (July - September) and the least occurrence 37 (18.0%) was recorded in the dry season (Jan – March). This was in agreement with the findings of Bourdin and Lef vre (1980) who reported the occurrence of PPR during the rainy season, but contrary to the findings of Abubakar *et al.* (2009) and Lancelot *et al.* (2002) who reported the disease occurring mostly during the dry season in most endemic

areas of Africa.

The prevalence of 34% (Tables 1 and 2) obtained from the current review falls within the range obtained in an earlier study conducted by Shamaki (2002) between 1995 and 2002, which reported the PPR seroprevalence rate in some states of Nigeria at 49% in sheep and 38% in goats but differ significantly with the study conducted by Woma *et al.* (2016) between 2010 to 2015 which reported a seroprevalence rate of 23% in the same country.

Age is also an important factor with animals aged 3–18 months being severely affected compared to adults or un-weaned young animals (Nawathe and Taylor, 1979). This is relative to the findings in these studies which show about 48% (101) of the affected population are Adults (10 months and above) were affected, while the young population

Table 3. Seasonal distribution of Peste des petits Ruminantis disease cases reported in National Veterinary Research Institute, Vom (2013-2022).

Season	PPR Case (%)	Total cases (%)	Prevalence rate (%)
Dry (Jan – Mar)	37(18.0)	116(19.3)	31.9
Pre- rainy (Apr – Jun)	54 (26.2)	137 (22.8)	39.4
Rainy (Jul – Sep)	69(33.5)	216(36.1)	31.5
Pre – dry (Oct – Dec)	46(22.3)	131(21.8)	35.1
Total	206(100)	600(100)	34.3

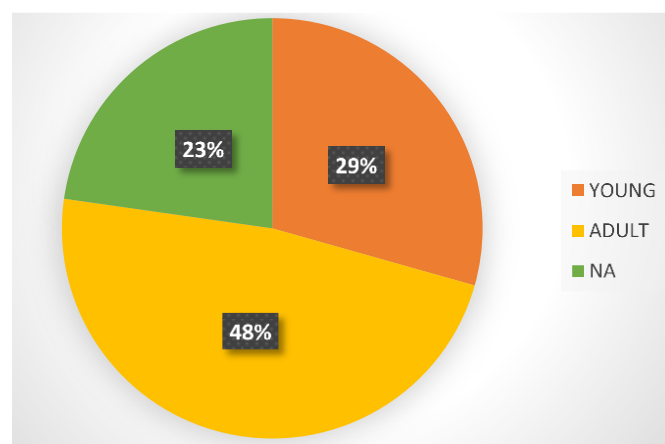
The result shows that the highest occurrence of PPR cases 69(33.5%) occurred in the Rainy season (July - September) and the least occurrence 37(18.0%) was recorded in the Dry season (Jan – March).

Table 4. Distribution of Peste des petits Ruminantis disease cases by State reported in National Veterinary Research Institute, Vom (2013-2022).

S/n	State	No. of PPR cases
1	Plateau	131
2	Bauchi	7
3	Kano	13
4	Oyo	3
5	Ebonyi	2
6	Kebbi	1
7	Osun	4
8	Yobe	10
9	Niger	2
10	Kaduna	4
11	Edo	1
12	Nasarawa	5
13	Borno	2
14	Ekiti	1
15	Imo	3
16	Benue	4
17	Yola	1
18	Calabar	1
19	Kwara	2
20	Lagos	6
21	Rivers	2
22	Katsina	1

makes up 29% (62) (Figure 7). Although the age categories are not the same, age certainly plays an important role in susceptibility to PPR disease. Most young animals die from the infection, having a very low chance of recovery compared to the adult population.

About 100 (48.5%) samples were diagnosed holistically for other concurrent infections, from which 67% were complicated by bacterial infection, 35% with Haemoparasite, 37 with Helminthiasis and 28 were complicated by coccidiosis. This agrees with the findings by Matur *et al.* (2023), Mann *et al.* (1974) and Saliki (1978) who state that a more severe form of disease results from mixed infections of bacteria, haemoparasites and viruses rather than by single infection. Poor nutrition, stress of movement and concurrent parasitic and bacterial infection may enhance the severity of clinical signs also (Mann *et al.*, 1974; Saliki, 1998; UNFCCC, 2020).

**Figure 7.** A pie chart showing the age distribution of Peste des petits Ruminantis diseases reported in the National Veterinary Research Institute, Vom over a period of 10 years (2013-2022).

Conclusion

This study further confirms the devastating effect of PPR disease, affecting sheep and goats, males and females of all ages. It remains a major economic disease affecting rural communities having the potential of destroying livelihoods. Increased mortality in small ruminant populations has been attributed to PPRV infection. Based on the findings of this study, the continued occurrence of outbreaks in Nigeria may not be attributed to the choice of vaccine but rather to other factors such as inadequacies related to the control strategy and lapses in Veterinary Extension Services in relation to PPR control. The United Nations Food and Agriculture Organization (FAO) and OIE also started two major projects in 2013 for the control of PPRV in Africa with financial support from the European Commission and the Bill and Melinda Gates Foundation respectively. The National Veterinary Research Institute, Vom, Nigeria, produces a 50-dose PPRV vaccine vial using the Nigeria 75/1 strain, with the recommendations that small ruminants must be vaccinated from 3 months of age and thereafter every 12 months. Its control should therefore be considered in programs that aim at alleviating poverty in developing countries.

Recommendations

There is a need to incorporate indigenous knowledge of livestock diseases for purposes of understanding diseases in the communities and setting up strong participatory surveillance systems that involve the communities as the basic element of disease surveillance intelligence gathering. Vaccination against PPR should be carried out regularly preferably on an annual basis to improve the herd immunity to levels that can contain the spread of the PPR disease with greater emphasis on vaccination to target the middle age group (>6 months). The government should ensure that the veterinary offices have adequate human resources to advise the local community on requisite measures to take to safeguard themselves against the negative impact of PPR. Community animal health workers should be trained and empowered to breach the gap where veterinarians are lacking. Peste des petits ruminants' disease control policy should envisage annual vaccination and focus on 100% coverage with priority given to middle-aged small stock. Awareness campaigns should be enforced, and the local pastoral structures need to be strengthened and aimed at sustainably enforcing sanitary disease control measures.

CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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