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Retrospective Study of Highly Pathogenic Avian Influenza Outbreaks From 2017 to 2021 in Plateau State, Nigeria

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ABSTRACT

Since its emergence in Nigeria in 2006, Highly Pathogenic Avian Influenza (HPAI) remains a major setback to the advancement of the poultry industry and intermittent outbreaks are still occurring across the country. The virus is zoonotic, with cases reported in humans. A Five-year retrospective study was conducted to extract information on the resurgence of the disease specifically the trend, geographical distribution, species of birds affected, mortality and zoonotic potential of the virus in Plateau State from 2017 to 2021. This was carried out by reviewing the available case reports and line lists of outbreaks of HPAI in the Avian Influenza desk office, Plateau State. Data were obtained and analyzed using descriptive and analytical statistics.

The results obtained showed that a total of 49 HPAI outbreaks were reported in Plateau State from 2017 to 2021, with the highest (53.06%) reported in 2021, the lowest (4.08%) in 2019 and no outbreak (0.0%) reported in 2018 and 2020. Layers were predominantly affected (59.19%). The outbreaks of Avian Influenza (HPAI) were reported in 5 Local Government Areas (LGAs), with the highest (53.06%) reported in Jos North and the lowest (2.04%) in Jos East and Mangu LGAs. The distribution of outbreaks by LGA and year showed that HPAI outbreaks were reported in 4 LGAs (Jos North, Jos South, Bassa and Mangu) in 2017, 2 LGAs (Jos North and Jos South) in 2019 and 4 LGAs (Jos North, Jos South, Bassa and Jos East) in 2021. Consequently, enhanced surveillance for Avian Influenza and awareness creation on prevention and control across Plateau State along with further motivation and support from the government are recommended.

Keywords: Avian influenza, HPAI, Surveillance, Zoonosis, Nigeria.

INTRODUCTION

Avian Influenza (AI) is an infectious and highly ruinous poultry disease of global public health significance. It is characterized by a highly infectious nature and mortality in poultry and it is zoonotic, with reports of human disease in different regions of the world (Rehman *et al.,* 2022). Recently, in the United States (US) there have been reports of outbreaks of highly pathogenic avian influenza HPAI (H5) in poultry and dairy cattle. Additionally, 9 cases of human avian influenza were reported in the US among dairy and poultry workers with 5 of the cases confirmed as H5N1 (CDC, 2024; Garg *et al.*, 2024)

In Nigeria, it was first reported in 2006 in Sambawa Farms in Northern Nigeria (Fasina *et al.*, 2009)

Avian influenza (AI) is caused by influenza A viruses (IAV) which are highly contagious, extremely variable viruses that are classified into subtypes based on the antigenic characteristics of their surface glycoproteins; 18 hemagglutinin (H1–H16) and 11 neuraminidases (N1–N9) (CDC., 2024; Kosik *et al.*, 2019). Each virus has one H and one N antigen, which can occur in any possible combination; all but H17N10 and H18N11 subtypes (found to date in Peruvian bats) circulate in wild aquatic birds, which is by far the largest of the known natural IAV reservoirs (Kosik *et al.,* 2019).

Influenza A viruses that infect poultry are classified into two strains: Low Pathogenicity Avian Influenza (LPAI) and High Pathogenicity Avian Influenza (HPAI) (Martins *et al.,* 2012). The LPAI strain causes a natural gastrointestinal infection of waterfowls and usually results in mild or no clinical manifestations (Umar *et al.,* 2017). In contrast, HPAI strain causes severe clinical manifestations and can cause high mortality rates in poultry (Selim *et al.,* 2017).

A key feature of an AI epidemic and virus is the ability to spread across a wide range of bird species (Saidu *et al.,* 2008). The introduction of the Avian Influenza virus into the Nigerian terrain was postulated to have been aided by migratory wild birds (FAO, 2004; Fasina *et al.,* 2009).

Contamination of the live bird trade chain in rural areas may occur through local poultry trade and this serves as a huge risk for the occurrence and spread of AI within the poultry population in Nigeria (Coker *et al;* 2014).

Control measures such as restriction of movement, culling, burying and burning, enhanced biosecurity and compensation are factors that have aided the control of the disease and some of these measures have been used in Nigeria after its first occurrence in 2006 (FAO, 2004; WHO, 2007).

The resurgence of this destructive poultry disease in 2017, 2019 and 2021 in Plateau State as unveiled in this study is an indication of its endemicity, which could be considered a huge risk to the poultry industry and can pose a public health risk (Alhaji *et al.*, 2023).

Establishing and adhering to functional biosecurity measures in addition to seeking proper veterinary care by poultry farmers are essential for the poultry industry in the state to thrive. The aim of this study is to review the resurgence of Avian Influenza specifically the trend, geographical distribution, species of birds affected, mortality and zoonotic potential of the virus in Plateau State from 2017 to 2021.

MATERIALS AND METHODS

Study Area

This study was carried out in Plateau State, Nigeria, one of the country's 36 states which is situated between latitude 08^{o} 24'N and longitude 008^{o} 32' and 010^{o} 38'E in the North-Central

geopolitical zone of Nigeria. The State comprises 17 Local Government Areas (LGAs) and 3 senatorial districts (Jos North, Jos Central and Jos South). According to the National Population Commission figures of 2006, the State had a population of 3,206,531. Plateau State occupies an area of approximately 26,899 km^2 and has a near temperate climate with an average temperature ranging between 13^{o}C and 22^{o}C. The coldest weather caused by harmattan winds occur between December and February while warmest temperatures typically occur during the dry season usually between March and April. The population engage mainly in farming and mining for subsistence. Many households keep backyard poultry while commercial poultry exists predominantly in the state's urban areas (Ejura *et al.*, 2020).

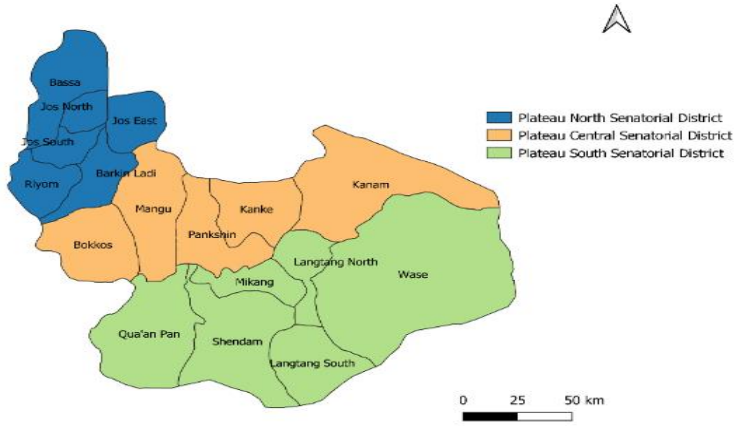


FIGURE I: Choropleth map of Plateau State showing the 17 LGAs across the 3 Senatorial Districts.

Data Collection

Secondary sourced data and records of AI outbreaks of 2017, 2019 and 2021 were collected and collated from the Plateau State Avian Influenza Desk Office, Jos. The personnel of the Avian Influenza Desk Office in collaboration with the Regional Disease Surveillance System Enhancement (REDISSE) team were involved in field epidemiological activities, disease surveillance, and disease outbreak investigations in the state upon notification of potential outbreaks of the disease.

The cases were diagnosed based on history, clinical signs and post mortem findings. Some of the signs observed in affected birds were high mortality, cessation in egg production, cyanotic combs and wattles, congested breast muscles and viscera and haemorrhages on the shanks and intestines. Samples from all cases were further sent to the National Veterinary Research Institute (NVRI) Vom, Nigeria for final and official confirmation

The data collected include: the farm name, name of farm owner, farm address and LGA, GPS location of the farm, species and type of birds, flock size, age of birds in weeks, number of cases, number of mortalities, number culled, date of onset, date reported, date culled and phone number of the farmer.

Data Analysis

The collected data were cleaned and analyzed using Microsoft Excel 2019 version to generate frequencies and proportions. The results were

presented as tables, graphs and charts (descriptive statistics). Quantum Geographic Information System (QGIS) 3.16.11 was used to generate the choropleth map of Plateau State and Epi info 7 was used to generate maps showing all the locations of the farms affected across Plateau State in 2017 and 2021.

RESULTS

A total of 49 outbreaks of Avian Influenza (HPAI) were reported in Plateau from 2017 to 2021, with the highest (26, 53.06%) reported in 2021, the lowest (2, 4.08%) in 2019 and no case (0, 0.00%) reported in 2018 and 2020 [Table I].

Overall, 155,115 poultry were affected (including mortalities and culls), with the highest number of cases recorded in 2021(86,700) and the lowest in 2019 (3,880) [Chart I]. The disease primarily affected layers in 2017 (26,213) and 2021(64,624) whereas pullets were majorly affected in 2019 (2900) [Table II].

There were 49 outbreaks of Avian Influenza (HPAI) recorded from 2017 to 2021 across 5 LGAs of the state. The highest incidence (53.06%) was in Jos North while the lowest (2.04%) was in Jos East and Mangu LGAs [Table III].

Based on yearly distribution; in 2017, HPAI outbreaks were reported in 21 farms in 4 LGAs (11 in Jos North, 7 in Jos South, 2 in Bassa and 1 in Mangu) with a total of 64,535 birds affected, out of which pullets were 57.80%, layers 40.61%, broilers 1.55% and turkeys 0.04%.

In 2019, 2 farms were affected in 2 LGAs (1 in each of Jos North and Jos South) with a total of 3,880 birds affected, out of which pullets were 74.74% and layers 25.26%.

Twenty-six (26) farms were affected in 4 LGAs in 2021 (14 in Jos North, 10 in Jos South, 1 in each of Jos East and Bassa) with a total of 86,700 birds affected, out of which layers were 74.537%, pullets were 21.703%, cockerels were 1.268%, broilers were 2.261%, noilers were 0.156%, local chickens were 0.032%. geese were 0.024%, guinea fowls were 0.013%, turkeys were 0.002% and peacocks were 0.002%.

The H5N1 strain of the Avian Influenza virus was implicated in the 2017 and 2021 outbreaks while the H5N8 strain was implicated in the 2019 outbreaks. (Ameji *et al.*, 2019; Adesola *et al.*, 2024).

During the period of the 2021 Avian Influenza outbreaks, an Avian Influenza Emergency Operation Centre (EOC) at level 1 was activated at national and state levels. The One Health National Rapid Response Team (RRT) from Nigeria Centre for Disease Control (NCDC) and Federal Ministry of Agriculture and Rural Development (FMARD) were deployed to Plateau State, where they collaborated with the Plateau REDISSE Team to conduct further investigations on the affected farms. Naso/oropharyngeal samples were obtained from 18 contacts (farm workers and farm owners), 14 in Jos North and 4 in Jos South LGAs. Three (3) out of the 18 contacts were positive for H5N1 (all 3 were asymptomatic), 2 in Jos South LGA with a prevalence of 50% and 1 in Jos North LGA with a prevalence of 7.14% (NCDC, 2021).

TABLE I: Number of outbreaks of Highly Pathogenic Avian Influenza and poultry species affected from 2017 to 2021 in Plateau State, Nigeria.

Year	Number of HPAI outbreaks	Percentage (%)	Number of affected poultry
2017	21	42.86	64,535
2018	0	0.00	0
2019	2	4.08	3,880
2020	0	0.00	0
2021	26	53.06	86,700
Total	**49**	**100.00**	**155,115**

Key: HPAI: High Pathogenicity Avian Influenza

TABLE II: The number and poultry species affected (including mortalities and culls) during the 2017, 2019 and 2021 Avian Influenza outbreaks in Plateau State.

Year	Pullets	Layers	Broilers	Turkeys	Noilers	Geese	G/Fowls	Peacocks	Cockerels	Local Chickens
2017	37,296	26,213	1000	26	-	-	-	-	-	-
2019	2,900	980	-	-	-	-	-	-	-	-
2021	18,817	64,624	1,960	2	135	21	11	2	1,100	28
Total	**59,013**	**91,817**	**2,960**	**28**	**135**	**21**	**11**	**2**	**1,100**	**28**

TABLE III: Distribution of Highly Pathogenic Avian Influenza outbreaks reported in Plateau State Nigeria from 2017 to 2021.

LGA	2017	2018	2019	2020	2021	Total	Percentage (%)
Jos North	11	0	1	0	14	26	53.06
Jos South	7	0	1	0	10	18	36.74
Bassa	2	0	0	0	1	3	6.12
Jos East	0	0	0	0	1	1	2.04
Mangu	1	0	0	0	0	1	2.04
Total	**21**	**0**	**2**	**0**	**26**	**49**	**100**

Key: LGA: Local Government Area

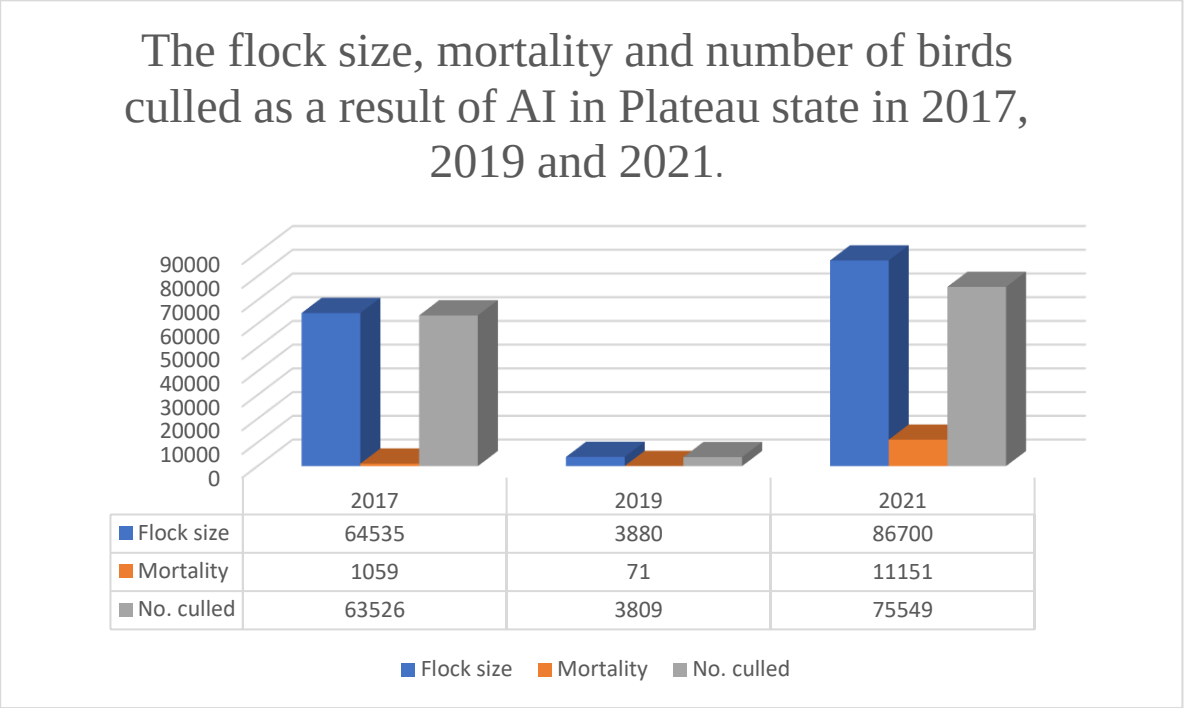
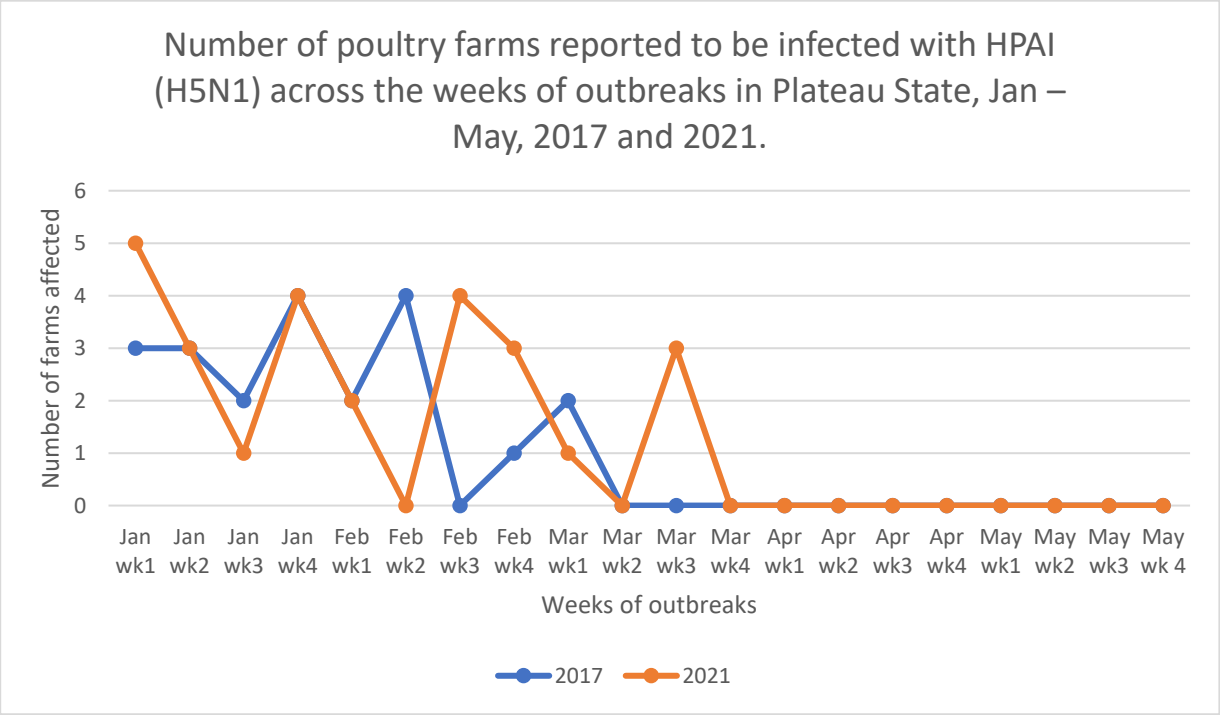


CHART I: The flock size, mortality and number of birds culled as a result of AI in Plateau state in 2017, 2019 and 2021.



GRAPH I: Number of poultry farms reported to be infected with HPAI (H5N1) across the weeks of outbreaks in Plateau State, Jan – May, 2017 and 2021.

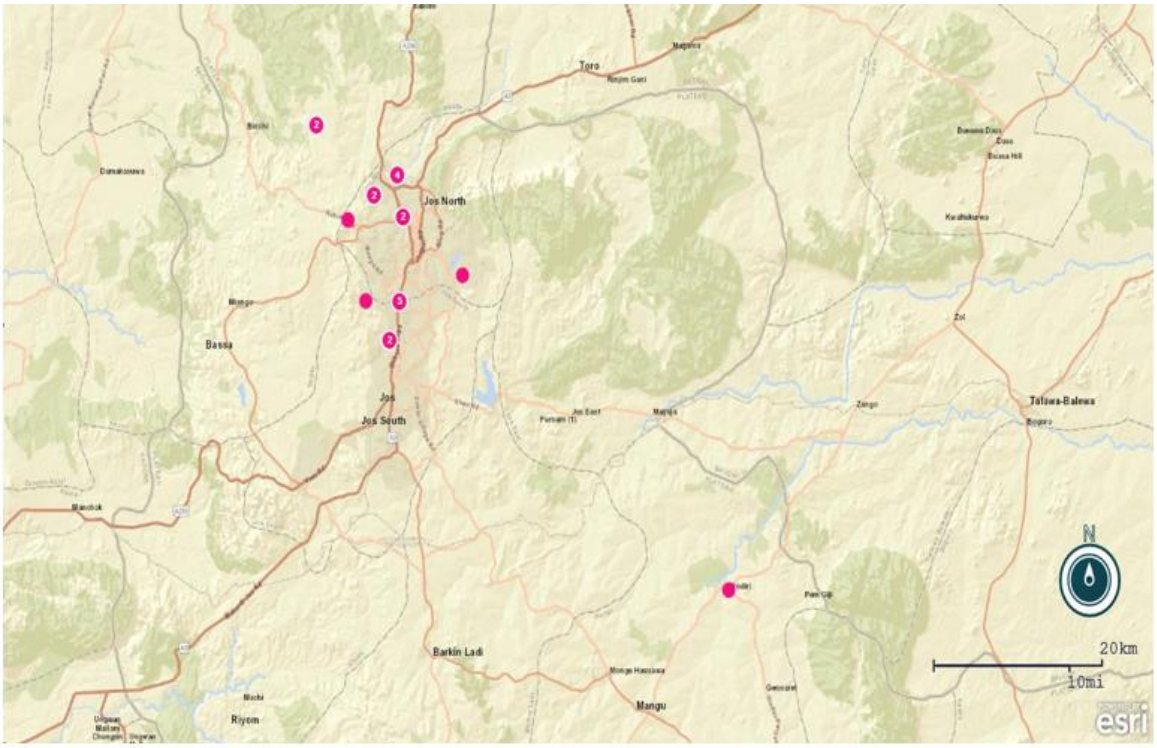


FIGURE II: Map showing case clusters of HPAI in Bassa, Mangu, Jos North and Jos South LGAs of Plateau State in 2017.

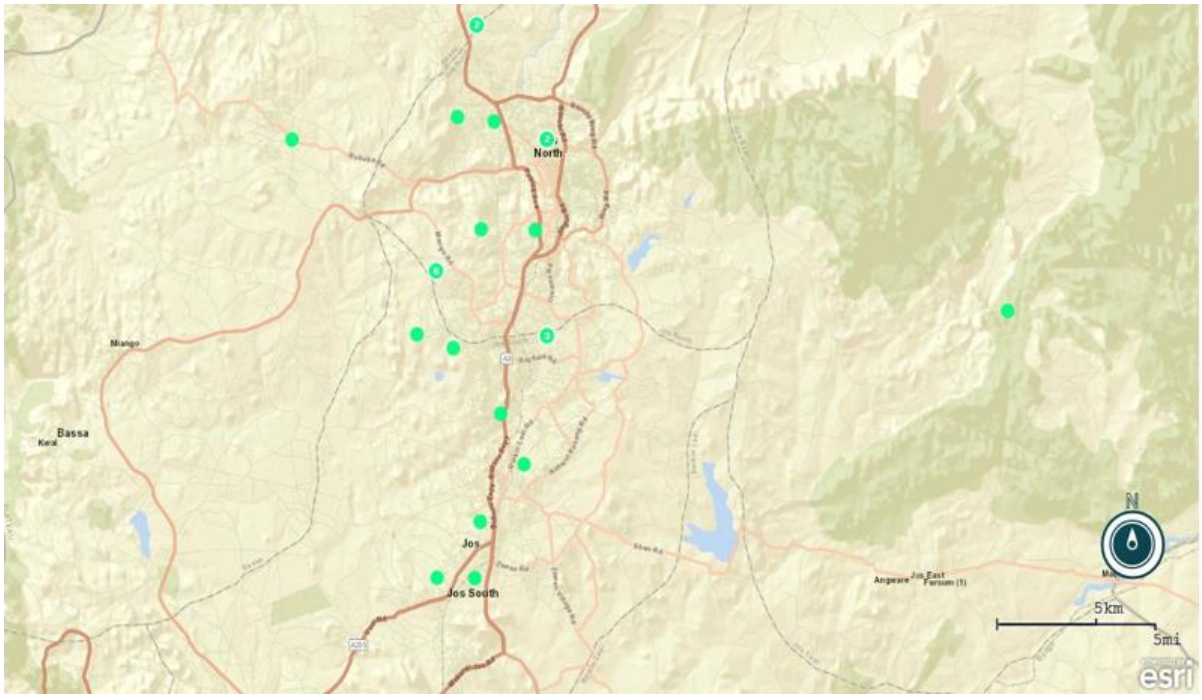


FIGURE III: Map showing case cluster of HPAI in Bassa, Jos North, Jos East and Jos South LGAs of Plateau State in 2021

DISCUSSION

Six states across five geopolitical zones in Nigeria were identified as hotspots for avian influenza outbreaks between 2015 and 2017. These states include Kano (North-West), Plateau and Abuja (Federal Capital Territory, North-Central), Bauchi (North-East), Rivers (South-South), and Oyo (South-West). The majority of the losses due to Avian Influenza (94.8%), occurred in the North-Central, North-East, and North-West zones during this period (Okoli, 2021).

The findings from this study showed that there were 49 cases of HPAI outbreaks reported in total in Plateau State from 2017 to 2021. The distribution of these outbreaks by LGA showed that the highest number of outbreaks were reported in Jos North LGA followed by Jos South LGA. Also, from the information obtained, the highest number of outbreaks occurred in 14 locations in Jos North LGA in 2021.

Twenty-one HPAI outbreaks were reported in 2017, no outbreak in 2018, two outbreaks in 2019, no outbreak in 2020 and 26 outbreaks in 2021.

The outbreaks that occurred in 2021 were significantly more than those that occurred in 2019. This may have been due to AI control measures which were in place in 2019, which included the distribution of control materials for AI by the Federal Department of Veterinary Services (Okoli, 2021).

Following HPAI outbreaks, farmers tend to employ strict biosecurity measures, depopulate flocks and allow farms to lie fallow. Also because of the poor/non-existent compensatory procedures in the country many farmers withdraw from the poultry business for a period of time. These could result in actual decrease in outbreaks in the years following an outbreak (Simancas-Racines *et al.*, 2023; Islam *et al.*, 2024).

The increase in reported outbreaks in 2021, coincides with several reports across Nigeria (Meseko *et al.*, 2023; Ogolo *et al.*, 2023). This increase may be attributed to enhanced surveillance within the State, facilitated by the mobilization of Regional Disease Surveillance Systems Enhancement (REDISSE) Project Veterinary Officers to the State by the Federal Ministry of Agriculture and Rural Development. In addition, increased awareness on AI during this period, both at the Federal and State levels could have contributed to the increase (Ogolo *et al.*, 2023). High concentration of poultry farms in the affected communities and increased reporting by farmers in these LGAs may be contributing factors and these could have been influenced by their proximity to the State capital, Jos.

All the AI outbreaks that occurred in the three years concerned (2017, 2019, 2021) occurred between January and April and these months are associated with low ambient temperature which reduces the immunity of poultry birds with increased disease susceptibility (Durand *et al.*, 2015). Most of the outbreaks of 2017 and 2021 occurred in clusters. This is suggestive of the rapid spread of the AI virus from one farm to another, hence more farms were affected in Jos North in 2017 and 2021. Poor biosecurity measures on most farms, Animal Health Service providers visiting multiple farms and egg merchants buying eggs from those farms in clusters are the major risk factors that precipitate the occurrence of the outbreaks in clusters (Gierak *et al.*, 2021).

Across the three years of AI outbreaks being observed, layers were the most affected, followed by pullets and broilers. In 2021 HPAI outbreaks,

the number of noilers, local chickens, geese, guinea fowls, turkeys and peacocks affected were few.

It is important to note that, the mortality recorded across the affected farms was the figure obtainable as at the time when the suspected AI cases were reported. No mortality was recorded in the guinea fowls, turkeys and peacocks as at the time the suspected AI cases were reported. Apart from the losses caused by high mortalities on the farms due to AI, there were also high numbers of live poultry that were destroyed as a preventive measure in the affected farms leading to high financial losses.

There was an occurrence of AI (H5N1) in three persons in Plateau state which is indicative of the zoonotic potential of the virus, though human to human transmission has not been established (NCDC, 2021). The primary risk factor for human infection seems to be exposure to infected live or dead poultry or contaminated environments (WHO, 2023). Also, Dinh *et al.*, 2006 identified lack of proper hand washing before and after farm operations among commercial poultry farm workers as a significant risk factor for human infection.

CONCLUSION

From 2017 to 2021, a total of 49 confirmed HPAI outbreaks were reported in Plateau State, Nigeria. These outbreaks were reported in 5 out of the 17 LGAs of Plateau State with Jos North LGA accounting for the highest- burden of HPAI in the State. No HPAI cases were reported in 2018 and 2020 across the state.

All the farms affected were in close proximity and with no or poor biosecurity measures in place. Layers, pullets and broilers were the most affected.

The positive cases of AI (H5N1) in humans should serve as a warning due to its potential public health risks.

The activities of the state Veterinary Department and Avian Influenza Desk Office should be heightened by the recruitment of more veterinarians and support staff, provision of facilities and equipment for rapid diagnosis, continuous training and re-training of staff and improved government support to improve surveillance and promote prevention and control of the disease in the State. There is also a need for continuous awareness, education and training of poultry farmers, poultry staff and live bird marketers on the disease and its zoonotic potential to increase their capacity to prevent and eradicate the disease.

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Ethical Approval

The research complied with Helsinki Declaration of 1964.

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