

**CLUSTER POULTRY FARMING, THE BANE OF HIGHLY PATHOGENIC AVIAN INFLUENZA SPREAD IN LAGOS STATE NIGERIA.****Odita, C. I^{1*}; Hambolu, M. A²; Olasoju, T. I³; Makanjuola, O. A⁴; Sito, O³; and Meseko, C. A⁵.**

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ABSTRACT

There have been no recorded epidemics of highly pathogenic avian influenza since September, 2016 in Lagos State, and since February 2019 in Nigeria. A resurgence occurred on the 25th of May, 2021. This study gives focused case report of fresh outbreaks of HPAI in Lagos state, south-western Nigeria. Investigation revealed that there were seventy four (74) epidemiologically linked outbreaks in six (6) locations: - Aiyedoto and Ojo military cantonment (Amuwo-odofin LGA), Ajah (Eti-osa LGA), Ago palace Okota (Isolo LGA), Oke-Oshodi (Epe LGA) and Badagry (Badagry LGA). Intensively managed, adult laying birds kept in clusters of less than 10 meters apart in Aiyedoto poultry farm settlement were predominantly affected. Disease prevalence was 15.7%. Incidence rate of infection was 0.2 per hundred bird-days at risk, associated mortality rate was 67 per x10³ birds. Real time PCR revealed HPAI H5N1. Stamping out of the entire bird population in affected areas was done. Barely a year after the 2021 outbreaks were curtailed, on the 16th of October, 2022 another outbreak was reported from Agricultural Youth Empowerment Scheme (AGRIC YES) poultry farm settlement. The outbreak at this time was reported in 5 locations: - Aiyedoto and Ojo military cantonment (Amuwo-odofin LGA), Araga (Epe LGA), Awoyaya Ibeju and Lekki (Ibeju-Lekki LGA). In all there were 16 outbreaks. Policy review regarding siting and spacing of poultry farm premises in addition to inter- and intra-state movement of birds is inevitable to control disease spread and reduce associated public health risk.

INTRODUCTION

Highly Pathogenic Avian Influenza (HPAI), a notifiable disease of zoonotic importance presents major threats to global poultry production and public health (Claes et al., 2016). The Eurasian lineage of the HPAI continues to circulate and cause outbreaks among poultry and wild birds in many parts of the globe including Africa (Zhang et al., 2010; Lee et al., 2017; Sulaiman et al., 2021). The disease was first reported on the African continent by Nigeria in 2006 (Joannis et al., 2006); with total mortality and depopulated figures in poultry being about a million (Akanbi & Taiwo, 2014), and a single human death (CDC, <https://www.cidrap.umn.edu/news-perspective/2007/01/nigeria-confirms-its-first-human-case-avian-flu>). Avian influenza disease has persisted in Africa and Nigeria, attributed mainly to the survivability of the virus due to its ability to evolve other subtypes (Lee et al., 2017), poor biosecurity compliance and husbandry methods by stakeholders (WHO, 2008; Ekong et al., 2018), unprotected or illegal trade in poultry and poultry products (Ducatez et al., 2006) and transcontinental migratory birds (Lycett et al., 2016; Meseko et al., 2018). The aims of this study are to give focused case report of outbreaks of HPAI (2021-2022) in Lagos State South-western Nigeria after about five years of no records of the disease in the state and to identify risk factors associated with the outbreaks.

MATERIALS AND METHODS

Outbreak history

The last time Lagos State experienced avian influenza epidemics was in September, 2016. Then came an isolated outbreak of the Highly Pathogenic

Avian Influenza H5N1 on the 25th of May, 2021 in a backyard farm consisting of ornamental birds in Ajah axis of Lagos State. Affected in this outbreak were 4 geese, 2 peacocks, 2 blue birds and 4 Muscovy ducks (Atuman et al, NVMA conference 2021). This outbreak was traced to Sokoto Live Bird Market in Nigeria. About one month later (30th June) another occurrence of the disease was reported in Aiyedoto poultry farm settlement 43km away from the initial outbreak. Prior to disease occurrence, the farm had a flock size of 1000 laying birds out of which 200 birds showed signs of illness. One hundred (100) adult laying birds were reported to have died within 4 days of disease incursion. Reports gathered that the 1000 birds present on this farm were vaccinated against Newcastle disease around the time of the outbreak. Subsequent to these, outbreaks were reported in Ago palace Okota, Ojo military cantonment, Oke-Oshodi and Badagry areas all within eleven days. Barely a year after the 2021 outbreaks were curtailed, on the 13th of October, 2022 peacock carcasses submitted to the Avian Influenza Laboratory of the National Veterinary Research Institute, Vom for investigation as to the cause of death confirmed an outbreak of HPAI H5N1 in another backyard farm consisting of ornamental birds in Lekki area of Lagos, Etiosa LGA. Affected in this outbreak were 13 peacocks and 4 cranes birds. Three days later, a distress call was received by the Lagos State Disease Response Team from AGRIC YES farm settlement in Araga Lagos, within the same LGA. There were mass mortalities of intensively managed, predominantly adult laying birds. On inspection, 7cages were affected and the clinical signs observed were swollen closed eyes, greenish diarrhea

unthriftiness, cyanotic combs, swollen comb and wattles and sudden death.

Disease investigation

For the outbreaks that occurred in 2021, disease investigation conducted by the Lagos State Disease Response Team comprising the Director of Veterinary Services, the Federal Epidemiology Officer, State Epidemiology Officer and Area Veterinary Officer, in collaboration with the National Veterinary Research Institute's Veterinary Investigation Officers revealed that the disease might have been introduced into Aiyedoto farm settlement in the early month of June from a farm in Ibadan and or from Igando. A live bird market (LBM) trader had purchased some birds from a farm in Ibadan and took the birds to LBM at Ojo Military Barrack (Cantonment). Aiyedoto farm settlement and Ojo Military barrack are within a short distance; many LBM traders and farmers from Ojo Military Barrack go to buy feed at Aiyedoto farm settlement. Another LBM trader was supplied 400 birds from Igando and also brought them to Ojo, all of which died within 4-7 days of purchase including 200 birds previously kept by this farmer. After the initial outbreak of the disease in Aiyedoto poultry farm settlement, the disease continued to spread rapidly over time while infecting many more pens due to the clustering nature of the farm premises where 213 poultry pens are being shared by 400 farmers. For the 2022 outbreaks, disease investigation also revealed that poultry pens were clustered together in large numbers in the AGRIC YES Farm settlement. Seven farmers with poultry pens housing a total number of eighteen thousand six hundred and sixty five (18,665) birds reported disease occurrence in their pens. Although evidence on possible epidemiological link between the backyard

ornamental poultry in Lekki and the Agric Yes Farm settlement in Araga is lacking, there are indications that outbreaks occurred earlier than October, 2022. This may be true owing to the positive H5N1 results from the National Veterinary Research Institute (NVRI) laboratory of poultry samples received from Ojo military cantonment and Aiyedoto poultry farm settlement (Amuwo-odofin LGA) and Awoyaya Ibeju (Ibeju-Lekki LGA) in the months of May and August, 2022 respectively. Clinical signs associated with the disease included: cyanosis of comb, wattles and appendages, greenish diarrhea, unthriftiness, swollen eyes, respiratory syndrome and high mortality. Intensively managed adult laying birds were predominantly affected, in addition to ornamental birds. Tissue samples were obtained and Multiplex RealTime RT-PCR test revealed highly pathogenic avian influenza H5N1 as the causative organism. Control measure instituted was stamping out of the entire bird population in affected locations.

RESULTS**TABLE 1:** Distribution of 2021 HPAI H5N1 outbreaks in Lagos state

Farm location	Number of farms affected	Total number of birds at risk	Number affected (%)	Number dead (%)
Aiyedoto	61	128,262	17,157	7,974
Ago palace okota	1	100	20	15
Ojo military cantonement	7	7,325	3,465	635
Ajah	3	2,700	1,530	720
Oke-Oshodi	1	2,950	200	150
Badagry	1	2,000	200	60
Total	74	143,337	22,572 (15.8)	9,554 (6.7)

During the 2021-2022 HPAI outbreaks, more than one hundred and seventy thousand birds (172,875) within the outbreaks locations were at risk of infection of which more than twenty seven thousand birds (15.72%) were infected and over ten thousand birds (6.3%) died. For the year 2021 outbreaks, disease prevalence was 15.8% with incidence rate of 0.2 per 100 bird-days at risk of infection and associated mortality rate of 67 per $\times 10^3$. For the 2022 outbreaks, disease prevalence was 15.6% with incidence rate of 0.1 per 100 bird-days at risk of infection and mortality rate of 42 per $\times 10^3$. Spatial distribution of outbreaks showed that the disease clustered in space in Amuwo-odfin LGA. Temporal distribution of the 2021 disease outbreaks showed high variation in disease incidence within the affected locations. The 2022 outbreak however was sporadic with isolated scarce cases in space and time and was prolonged. DNA sequencing performed by Instituto Zooprofilattico Sperimentale Sella Venezia (IZSVE) Padova, Italy revealed that disease occurrences during the 2021 -2022 HPAI outbreaks in Lagos state were due to H5Nx clade 2.3.4.4b.

TABLE 2: Distribution of 2022 HPAI H5N1 outbreaks in Lagos state.

Farm location	Number of farms affected	Total number of birds at risk	Number affected (%)	Number dead (%)
Aiyedoto	3	1,745	164	138
Araga	8	20,830	3,710	843
Awoyaya Ibeju	1	2,950	296	88
Lekki	1	13	10	10
Ojo military cantonement	3	4,000	431	170
Total	16	29,538	4,611 (15.6)	1,249 (4.2)

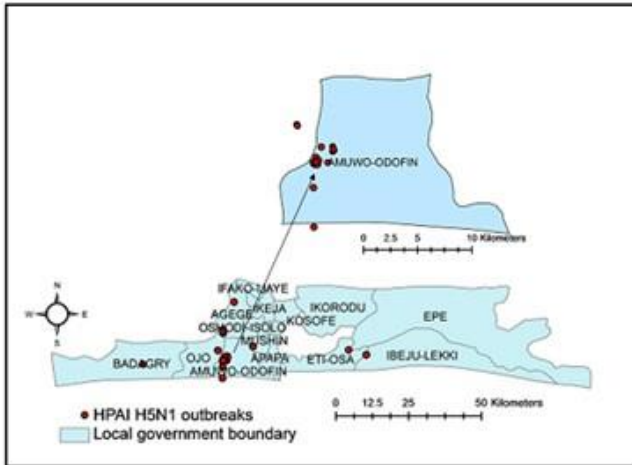


Figure 1: Spatial display of outbreaks locations in Lagos state.

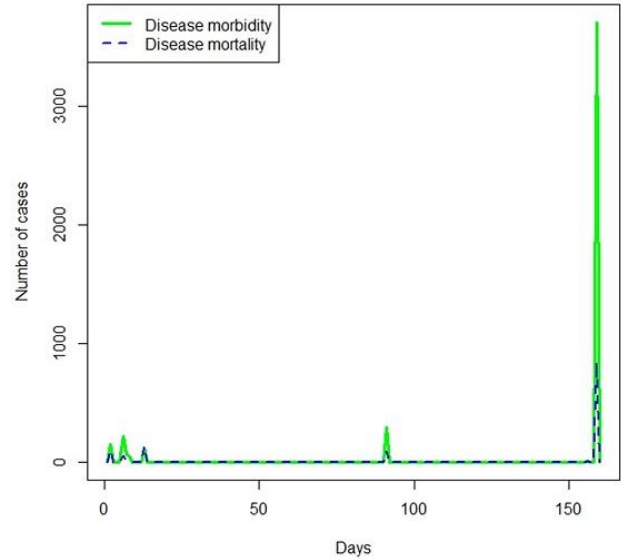


Figure 3: Epidemic curve of HPAI H5N1 outbreaks in Lagos State (2022).

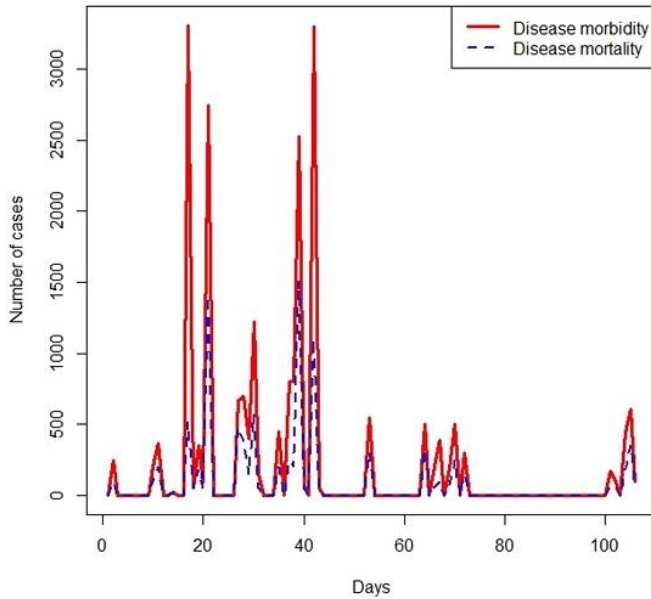


Figure 2: Epidemic curve of HPAI H5N1 outbreaks in Lagos State (2021).

Biosecurity issues

A number of biosecurity issues predispose the Aiyedoto and AGRIC YES farm settlements to outbreaks of highly pathogenic avian influenza. Many feed stores in Aiyedoto farm settlement either do not have foot dips, or when present is non-functional (Figure 4a). Live bird traders especially from LBM in Ojo military barracks visit these feed stores having also had contacts with other LBMs outside the state. Aiyedoto farm settlement has a central egg collection point where farmers gather eggs (Figure 4b). Egg merchants have unrestricted access to this collection point on the farm. The distance between pens is usually less than a meter, and sometimes individual pens are shared by two or more farmers; this is in addition to unauthorized pens which are common features within the farm settlements bringing about congestion. Furthermore, farmers commonly share trucks and wheel barrows to transport eggs, feed and manure from one farm to another (Figure 4c and

4d). The situation at the AGRIC YES farm settlement is similar to Aiyedoto farm settlement in which poultry pens are in clusters, in addition to rearing birds of different species together in the same cage. In the two farm settlement locations, environmental pollution is a common feature (Figure 4e).



Figure 4a: Feed store without functional foot dip



Figure 4b: central egg collection point



Figure 4c: Trucks and wheel barrows shared by farmers for egg collection,



Figure 4d: wheel barrows shared by farmers for feed and manure.



Figure 4e: Dirty farm environment.

DISCUSSION AND CONCLUSION

The prevalence of highly pathogenic avian influenza disease during the 2021 and 2022 outbreaks in Lagos state remained consistent. However, disease occurrence in the state during the year 2022 was sporadic and more aggressive in nature considering the incidence and mortality rates against the disease morbidity. DNA sequencing showed that disease occurrences in the two years were from the same introduction. It is possible that the disease introduction in 2021, following a breakdown in barrier maintenance assumed an endemic status within Aiyedoto poultry farm settlement and Ojo LBM. Continual biosecurity breaches culminated in the sporadic outbreaks experienced in the state in 2022. This can be explained by the earlier disease occurrence from Ojo LBM and Aiyedoto poultry farm settlement two months before occurrence in Araga farm settlement. Considering the pattern of the disease spread during the 2021 and 2022 outbreaks, it is pertinent to say that Ojo LBM and Aiyedoto poultry farm settlement in Lagos state may serve as the source of avian influenza disease infection in the state. Cluster farming is a major biosecurity risk promoting widespread of HPAI. Certain environmental factors such as poor biosecurity compliance in poultry farms in addition to high poultry farm density, presence or abundance of rivers, lakes or wetlands that attract water fowls, and anthropogenic variables involving human population density (Gilbert & Pfeiffer, 2012) are important predictors for spatial and temporal clustering of HPAI cases. In Aiyedoto and AGRIC YES poultry farm settlements where disease outbreaks predominantly occurred during the two years of infection, it was observed that birds were kept in close clusters, in addition to mixed-species breeding and dirty farm surroundings. Presence or

abundance of wild birds (Lycett et al., 2016), proximity to roads, social networks and value chain forces (Rivas et al., 2010; Oluwayelu et al., 2020) have also been previously described. The Eurasian lineage of the clade 2.3.4.4b H5Nx influenza viruses associated with the 2021-2022 HPAI outbreaks in Lagos state has been described to be widely circulated among wild birds in Europe, Africa, Asia, and North America since October 2020 (Cui et al., 2022). The route of introduction of this clade from wild birds to poultry during the 2021-2022 HPAI outbreaks in Lagos state is most probable from Live Bird Markets as they serve as points for mixing birds of different species. The history obtained from the 2021 outbreaks showed indiscriminate movement of birds from LBMs to backyard poultry and poultry farm settlement. A similar occurrence was observed in the findings of Sulaiman et al. (2021), where live bird markets were linked to every outbreak identified during the survey. Backyard ornamental bird farms have been implicated to play a significant role in the transmission of HPAI disease (Edmunds et al., 2011). This is buttressed by the reports of the disease in two backyard ornamental poultry farms during the 2021-2022 outbreaks. Furthermore, poor preventive practices by farmers as observed in this outbreak report where farmers purchased birds from unverified sources, shared farm implements and tools and visited themselves on their farms to empathize with one another for losses, greatly contributed to the widespread of this outbreak. It is imperative for the Lagos State Ministry of Agriculture to educate poultry farmers on good biosecurity practices and review policy on siting and spacing of poultry farm premises. Indiscriminate intra- and inter- state movement of birds is one practice that must be curtailed by appropriate authorities to control

disease spread and reduce public health risk.

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