

PREVALENCE AND HERD HEALTH OF AFRICAN SWINE FEVER DISEASE IN SOUTH EASTERN STATES IN NIGERIA

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ABSTRACT

African Swine Fever (ASF) outbreak poses a major economic threats to swine production in Nigeria, leading to substantial livelihood disruptions. Understanding the spatial spread of the disease is important for devising effective control measures especially in the absence of an effective vaccine. This study assessed the spatial distribution of ASF spread in selected south eastern States of Nigeria. A total of 264 pig farmers were randomly selected from Abia, Imo, and Enugu States to evaluate the herd-level prevalence of ASF. A structured questionnaire was administered to obtain data on socio-demographic characteristics and risk factors associated with disease outbreak in pig farming. The awareness of ASF among pig farmers was notably high (82.96%), and most respondents recognized key clinical signs. Educational level was significantly associated with ASF knowledge ($P = 0.0001$). The overall sero-prevalence was 8.3%, with no positive cases detected in Abia and Imo States. Significant risk factors included: feeding pigs with kitchen leftovers containing pork ($P = 0.0501$), use of leftovers sourced from restaurants serving pork ($P = 0.0135$), sourcing pigs from infected farms ($P = 0.0135$), neighboring farms with known infections ($P = 0.0362$), and tick infestation by *Ornithodoros* spp. ($P = 0.0501$). These factors were identified as major contributors to ASF transmission in the region. Targeted farmer education and integrated biosecurity strategies are critical for preventing recurrent outbreaks.

Keywords: African swine fever, herd-health prevalence, south-eastern Nigeria, swine

INTRODUCTION

African Swine Fever (ASF) is a highly contagious and lethal viral disease affecting domestic and wild pigs. It is caused by the African Swine Fever Virus (ASFV), which belongs to the Asfarviridae family. While ASF does not pose a zoonotic threat, it has devastating impacts on pig production systems, food security, and the global pork industry. The disease is typically characterized by high fever, widespread hemorrhages, and mortality rates approaching 100% (Blome *et al.*, 2020).

African swine fever (ASF) is a transboundary animal disease which affects swine production globally (FAO, 2013). The soft ticks of the genus *Ornithodoros* serves as a maintenance host for the ASFV and is also the only known

DNA arbovirus that replicates in these soft ticks (Gaudreault *et al.*, 2020; Jori *et al.*, 2023). While this tick has been reported across several African countries, it has never been detected in Nigeria (Jori *et al.*, 2023). Hence, in Nigeria, the virus is primarily transmitted via direct and indirect contact between pigs (domestic and wild), pig products, and contaminated fomites or foods (Danzetta *et al.*, 2020).

Typical ASF disease has four stages of onset: peracute (sudden death), acute (High fever, vomiting, cyanosis, abortion of pregnant sows, subacute (Abortion, mortality rate of 30%-70%), chronic (weight loss, undulating fever) (Yoon *et al.*, 2020).

Despite several national interventions, ASF continues to challenge control efforts in Nigeria. An ASF outbreak in a

farm cluster in Lagos State revealed the presence of ASFV Genotype II (Adedeji *et al.*, 2021), a variant previously alien to Nigeria and West Africa (Dixon *et al.*, 2020). This had critical implications on the previous control measures against this disease and food security. The major control measure against ASF outbreaks is the culling of all pigs in affected and contact pig farms due to the practice of cluster farming by most pig farmers, especially in developing countries like Nigeria (Adedeji *et al.*, 2021).

As no approved vaccine or specific treatment currently exists, to limit the transmission and effect of ASF (WOAH, 2019a), early detection of the disease in both domestic and wild pigs via targeted active surveillance or syndromic surveillance and the implementation of appropriate contingency plans have been considered effective means of preventing the ASF outbreak (Danzetta *et al.*, 2020).

This study investigates herd-level sero-prevalence of ASF and associated risk factors under enzootic conditions in Southeast Nigeria, providing insights essential for improving surveillance and disease mitigation.

MATERIALS AND METHODS

STUDY AREA AND STUDY DESIGN

The study areas for this study were in three States in South-eastern Nigeria, namely Abia, Imo and Enugu. Abia State lies at approximately latitude 5°29'N and 7°33'E, Imo State at 5°29'N and 7°20'E, and Enugu State at 6°27'10'N and 7°30'40' of the equator. (Adiele *et al.*, 2005). Blood samples were collected from pig population from both commercially managed and traditionally managed pigs within Abia, Imo and Enugu State

SAMPLE COLLECTION

Ethical approval (Ref No: MOUAU/CVM.REC/202116) was obtained from the Ethical Committee of the College of Veterinary Medicine, Michael Okpara University of Agriculture, Umudike, on October 10, 2023. Informed consent was obtained from all 264 participating farmers prior to data collection, consistent with the terms of ethical approval.

SAMPLE SIZE DETERMINATION

A minimum sample size of 390 for questionnaire and serum sample size of 550 was calculated using the Raosoft® sample size calculator available at: <http://www.raosoft.com/samplesize.htm> (Raosoft, 2020). The sample size computation assumed an estimated target population of 20,000 pigs (since there is no record of current population of pigs in South-East Nigeria, from available literature), 5% error margin, 95% confidence level and 50% prevalence.

A total of 543 blood samples were collected from different suspected pigs from the three states of Nigeria. One hundred

and eighty blood samples (5mls) from different pigs from Abia state, one hundred and seventy three blood serum samples in Imo State and one hundred and eighty one blood serum samples from different pigs from Enugu State. The blood was collected from live animals through the ear vein in different tubes for each animal in a vacutainer tube without anticoagulant. All the samples collected were placed in a cooler with ice pack until further processing.

QUESTIONNAIRE SURVEY

A closed-ended questionnaire carefully worded questions that were categorized into sections (socio-demographic data, general information and animal health status, disease morbidity and mortality, disease risk practices, veterinary care on outbreak of ASF) were used for this study. The questionnaire was structured, validated and pilot-tested before deployment. During the validation, the questionnaire was first subjected to face and content validations, as described by Bolarinwa (2015).

ANTIBODY DETECTION TEST

The detection of antibody against ASF was carried out by indirect Enzyme Linked Immunosorbent Assay (ELISA) as recommended by the manufacturer (Sunlong Biotech Co Limited, China). ELISA was carried out in a 96 wells as described by (Asambe *et al.*, 2018). Briefly, all the reagents were prepared before starting assay procedure and all standard and samples were added in duplicate to the Microelia Stripplate. The positive and Negative controls 50µl were separately added to the Positive (A1, B1) and Negative well, (G1, H1) then, add 50µl of sample to testing sample well. 100µl of HRP-conjugate reagent were added to each well and it was covered with an adhesive strip and incubates for 60 minutes at 37°C. Each well was aspirated and washed. The process is repeated four times for a total of five washes. Wash by filling each well with wash solution (400 µl) using squirt bottle. After the last wash, the washing Solution was removed by decanting, then the plate was inverted and blot against clean paper towels. Chromogen solution A 50µl and chromogen solution B 50µl were added to each well. It was gently mixed and incubates for 15 minutes at 37°C. Lastly, the reaction was stopped by adding 50µl of stop solution to each well. Antigen antibody reaction took place in the positive wells to give a yellow coloration. The Optical density (OD) of all samples was simultaneously measured at 450nm wavelength using an ELISA microtiter plate reader (UNIEQUP ELISA Reader, Germany, A3 2009 Model).

DATA ANALYSIS

Data analysed was carried out using Statistical Package and Service Solutions (SPSS) software. Descriptive statistics

and inferential statistics were used to analyse data obtained from the questionnaire. Chi square and Fishers Exact tests were used to test for association between categorical variables. The significant difference was measured at $P < 0.05$.

RESULTS

TABLE I: RESULTS OF INDIRECT ENZYME LINKED IMMUNOSORBENT ASSAYS

State	Total no. of samples (n=543)	No. of positive samples	No. of negative samples	Sero prev. %
Enugu	181	15	165	8.3
Abia	180	0	180	0
Imo	173	0	173	0

Only fifteen (15) pigs that represented 8.3% of the total sample tested positive. On the contrary, there was no positive result in pigs from Abia and Imo state. The overall percentage positive was 8.3 % (Table I).

DEMOGRAPHIC CHARACTERISTICS OF THE RESPONDENTS

Out of 264 respondents that participated in the study, 72 (27.3 %) were females while 197 (74.6%) were males. Respondents 16-25 years were 18 (6.8%) and 26-35 years were 54 (20.5%). Based on the qualification of respondents, 27 (10.2%) had Primary School education and majority 105 (39.7%) had Secondary School education. Respondents farming experience were 1-5 years 27 (10.2%), 6-10 years 84 (31.8%), and majority were ≥ 16 years 114 (43.2%). The majority of the breeds were mixed breeds (Table II). Education qualification ($P=0.0001$) and State ($P=0.0001$) were the socio-demographic variables associated with ASF outbreak were statistically significant (Table II).

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TABLE II: SOCIO-DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS (N=264)

Variable	Freq.	Per. (%)	No. of pig that tested positive	P-value
Gender				
Male	197	74.6	12	0.7661
Female	72	27.3	3	
Marital status				
Married	174	65.9		
Not married	90	34.1		
Farmers' age (years)				
16-25	18	6.8		
26-35	54	20.5		
36-45	114	43.1		
≥ 45	78	29.5		
Mean	40.05 \pm 6.33			
Education qualification				
No formal education	39	14.8	9	0.0001*
Primary	27	10.2	3	
Secondary	105	39.7	3	
Tertiary	95	35.9	0	
State				
Abia	105	39.8	0	0.0001*
Enugu	66	25	15	
Imo	93	35.2	0	
Pig farming experience				
<5 yrs	27	10.2	9	0.1655
6-10yrs	84	31.8	3	
11-15yrs	39	14.8	3	
≥ 16 yrs	114	43.2	0	
Breeds				
Local	42	15.9		0.1489
Mixed	171	64.9		
Exotic	51	19.3		

HERD HEALTH INFORMATION AND DISEASE PREVALENCE OF ASF

Slightly more than half of the respondents (53.4%) reported maintaining health records for their pig farms. Among those who did not keep records, the most common reasons cited included reliance on memory (73.9%), being too busy (12.5%), and finding it cumbersome (6.8%).

TABLE III A: HERD HEALTH INFORMATION AND DISEASE PREVALENCE ON ASF (N=264)

QUESTION ASKED	RESPONSES	NO.OF RESPONDENTS (%)
Keeping health records	Yes	141(53.4)
	No	123(46.6)
If not, why?	To busy	33(12.5)
	Cumbersome	18(6.8)
	Not educated	18(6.8)
	Reliance on memory	195(73.9)
Common disease affecting pigs	African swine fever	96(36.4)
	Helminthiasis/ endoparasitism	60(22.7)
	Mange	84(31.8)
	Hog Cholera	5(2)
	Others	19(7.1)
Diseases that cause the highest mortality in your piggery	African swine fever	96(36.4)
	Helminthiasis/ endoparasitism	60(22.7)
	Mange	84(31.8)
	Hog Cholera	5(2)
	Others	19(7.1)
Clinical Signs observed	High fever	36(13.6)
	Sudden death	30(11.4)
	Huddling	21(8.0)
	Emaciation and weight loss	45(17.0)
	Diarrhea	21(8.0)
	Abortion in pregnant sows	9(3.4)
	Redness of skin, ear, leg and abdomen	9(3.4)
	In-appetence	30(11.4)
	All of the above	63(23.9)

Regarding disease prevalence, African Swine Fever (ASF) was identified by 36.4% of farmers as the most frequently encountered disease. Other reported conditions included mange (31.8%), helminthiasis (22.7%), and Hog Cholera (2%). ASF was also regarded as the leading cause of mortality (36.4%), followed again by mange and helminthiasis.

Adult pigs were reported to be the most affected age group (40.9%), followed by growers (28.4%) and weaners (19.3%). A substantial proportion of farmers (83%) indicated prior awareness of ASF. Among these, the main sources of information were other farmers (53.4%), veterinary or extension officers (25%), media (8%), and government

sources (6.8%). Only a small percentage of respondents (17%) had no prior knowledge of the disease.

Clinical signs most commonly recognized by farmers included weight loss/emaciation (45%), high fever (36%), and inappetence. Less frequently observed signs included redness of the skin or ears (9%) and abortion in sows (9%). (Table II)

TABLE III B: HERD HEALTH INFORMATION AND DISEASE PREVALENCE ON ASF (N=264)

QUESTION ASKED	RESPONSES	NUMBER OF RESPONDENTS (%)
Group most affected with ASF	Piglets (newborn)	30(11.4)
	Growers	75(28.4)
	Weaners	51(19.3)
	Adult	108(40.9)
Heard about ASF before	Yes	219(83)
	No	45(17)
Heard from	Veterinarians/ Veterinary extension officers	21(8.0)
	Media	18(6.8)
	Other farmers	141(53.4)
	Government officers	18(6.8)
Others sources	Others sources	66(25)
Have had confirmed outbreak of ASF	Yes	150(56.8)
	No	114(43.2)
Season of ASF	Rainy Season	81(30.7)
	Dry Season	69(26.1)
	No particular season	114(43.2)

RISK PRACTICES FOR AFRICAN SWINE FEVER

Majority of the respondents (53.4%) reported that they replaced their stock from the neighbourhood farms after the incidence of ASF. Approximately 12.6% said that they replaced their stock from commercial farmers, while 11.4% agreed that they replaced their stock from NGOs. Also 6.8% of the respondents affirmed that they replaced their stock from research project stock whereas another 6.8% reported replacement of their stock from their own previous stock (Table IV). With respect to the livestock management system adopted, more than half of the farmers (55.7%) agreed adopting intensive system, 22.9% adopted semi-intensive system, 11.4% adopted free-range system while 10.2% adopted tethering system (Table IV).

The type of feed the farmers reported feeding their stock with ranges from PKC (27.3%), kitchen leftovers (19.3%),

maize bran (18.9%), spent grain (17%), hotel leftovers (9.1%), wheat offal (4.5%), rice polish (1.1%) and others (2.7%) (Table IV). Approximately 35.6% of the farmers affirmed that they fed their pigs with kitchen leftovers that contained pork. Out of these, 27.3% agreed that they purchased their feed from hotels that serve pig products. Majority of the farmers (48.9%) reported that they purchased their feed apart from kitchen leftovers and hotel leftovers from farmers. 26.1% said they purchased from company while 25% agreed that they sourced from market. With respect to drug administration, 44.3% of the farmers agreed that they treat their swills (Table IV).

TABLE IV A: RISK PRACTICES FOR ASF (n = 264)

QUESTIONS ASKED	RESPONDENTS	NO. OF RESPONDENTS	P- VALUE
Source of replacement stock	Fellow farmers	141(53.4)	0.1918
	Research projects	18(6.8)	
	Commercial farmers	57(21.6)	
	NGOs	30(11.4)	
	Own source	18(6.8)	
	Management system	Free ranging system	
	Tethering system	27(10.2)	
	Semi-intensive system	60(22.7)	
	Intensive system	147(55.7)	
Fed pig with kitchen left over containing pork	Yes	35.6	0.0501*
	No	64.6	
If the kitchen left over is usually soured from restaurants, does that hotel serve pig products?	Yes	72(27.3)	0.0135*
	No	192(72.7)	
Do you treat the swills?	Yes	117(44.3)	0.7945
	No	147(55.7)	
Introduce your pig stocks into the herd before disease outbreak	Yes	146(54.5)	
	No	118(44.5)	
Source of pig(s)	Market	72(27.3)	0.0135*
	Pig farms	192(72.7)	

*Statistically significant p-value; Fisher's exact test (GraphPad Prism®, version 8.0.4, CA, USA)

TABLE IV B: RISK PRACTICES FOR ASF (n = 264)

QUESTIONS ASKED	RESPONDENTS	NO. OF RESPONDENTS	P- VALUE
Source of pig(s)	Market	72(27.3)	0.0135*
	Pig farms	192(72.7)	
Contact with Infected neighbourhood	Yes	153(58)	0.1053
	No	111(42)	
Ticks observed in pig pens	Yes	93(35.2)	0.0501*
	No	171(64.8)	
Sharing of farm equipment	Yes	171(64.8)	0.2708
	No	93(35.2)	
If yes, which equipment?	Farm Boots and Apron	33(12.5)	
	Wheel Barrow	123(47)	
	Shovels	15(5.7)	
	Vehicles	9(3.5)	
	Buckets	66(25)	
	Others	18(6.8)	
	Rats having access to your feed store or pig pens	Yes	
	No	81(30.7)	
Wild bird enter pig pens	Yes	117(44.3)	0.7945
	No	147(55.7)	
Have your neighbours encountered ASF	Yes	141(53.4)	0.0362*
	No	123(46.6)	
Disposing of dead pigs	Burning	22(8)	0.3716
	Burying	58(22)	
	Selling	122(46)	
	Others	62(24)	
Wild pigs around pig pens	Yes	57(21.6)	
	No	207(78.4)	
Sale method	In the market	12(4.6)	
	To farms	30(11.4)	
	Others	222(84)	

*Statistically significant p-value; Fisher's exact test (GraphPad Prism®, version 8.0.4, CA, USA)

Regarding the source of ASF infection, 58% of the farmers admitted that they had contact with ASF infected pig farms within their neighbourhood. Among these, 35.2% had their pigs co-infected with ticks, 64.8% reported sharing farm equipment with other farmers among which 47% shared wheel barrows, 25% shared buckets, 12.5% shared booths and aprons, 5.7% shovels, 3.5% vehicles and 6.8% other equipment not listed.

Most of the respondents (69.3%) reported rat invasion to their feed stores or pig pens while 44.3% reported entrance of wild birds in addition to their pig pens. More than half of the farmers (53.4%) affirmed that their neighbourhood farms had encountered ASF outbreak previously (Table IV).

In addition to biosecurity measures, 46% of the respondents reported selling of their dead pigs, 22% buried the dead pigs, 8% burnt them while 24% used other methods to dispose the dead pigs. Out of the respondent, 21.6% agreed that wild pigs came around their farms.

The percentage of farmers that agreed selling their pigs to other farms was 11.4%, those that sold in the market were 4.6% while 84% used other means to sell their pigs (Table IV). Feeding pig with kitchen left over containing pork (0.0501), hotel serving pig products (0.0135), Source of pig(s) (0.0135), Ticks observed in pig pens (*Ornithodoros* spp.) (0.0501) and neighbours encountered ASF (0.0362) were the risk practices variables associated with ASF outbreak were statistically significant (Table IV).

MORBIDITY AND MORTALITY

Majority of the respondents (40.25) agreed that their pigs started manifesting signs of ASF after stocking their farms with new pigs. Among these, 26.1% reported manifestation

of the signs after they compromised biosecurity, 22.7% reported manifestation of the signs after exposing their pigs to other farms, 4.6% reported observing the signs after wild pig incursion, 3.4% after introduction of new feed and 3.0% before stocking with new pigs (Table V).

According to the age groups kept by the farmers before the outbreak of ASF, 31.8% of the farmers were keeping weaners, 15.9% adult boar/sow, 8% growers, another 8% piglets while 36.4% of the farmers were keeping all the age groups (Table V). Regarding the pig age groups mostly affected by the ASF outbreak, most of the farmers (55.7%) reported adult boar/sow being the mostly affected by the ASF, 14.8% reported growers, and 11.4% reported weaners, 4.6% piglets, while 13.6% reported all the age groups being affected.

Regarding the casualties according to the pig age groups during the outbreak, majority of the farmers (40.9%) reported mortality across all the age groups, 17.4% reported death of piglets, 13.3% adult/sow, 9.5% weaners while 8.5% reported growers (Table V).

In terms of intervention provided during the ASF outbreak, 31.8% of the farmers slaughtered the pigs, 31% sold out the pigs, 28.2% did not take any action, 5.7% applied disinfectants while 2.3% offered treatment. Most of the farmers (39%) that applied disinfectants purchased it from open markets, 36.7% from veterinary pharmacy, 14.4% used

TABLE V: MORBIDITY AND MORTALITY CAUSED BY ASF (n=264)

QUESTIONS ASKED	RESPONSES	NO. OF RESPONDENTS
Pig introduction when they started manifesting the signs	After stocking with new ones	106(40.2)
	Before stocking	8(3.0)
	After exposure to pigs from other farms	60(22.7)
	After wild pig or wildlife incursion	12(4.6)
	After compromised biosecurity	69(26.1)
Age groups kept before the outbreak	After introduction of new feed	9(3.4)
	Adult boar/sow	42(15.9)
	Growers	21(8.0)
	Weaners	84(31.8)
	Piglets	21(8.0)
Group most affected with ASF	All of the above	96(36.4)
	Adult boar/sow	147(55.7)
	Growers	39(14.8)
	Weaners	30(11.4)
	Piglets	12(4.6)
How many pigs died?	All of the above	36(13.6)
	Adult boar/sow	35(13.3)
	Growers	22(8.3)
	Weaners	25(9.5)
	Piglets	46(17.4)
Action taken to pigs during ASF outbreaks	All of the above	136(51.5)
	No actions	77(29.2)
	Slaughtered	84(31.8)
	Sold	82(31)
	Treatment	6(2.3)
Source of disinfectant used	Disinfection	15(5.7)
	Others	0(0)
	Home-made	38(14.4)
	Bought from veterinary pharmacy	97(36.7)
	Bought from open market	103(39)
Disinfecting procedures used	Directly from company/manufacturer	26(9.8)
	Thoroughly washed and disinfect	91(34.5)
	Mix disinfectant with water and use	141(53.4)
	Disinfect only without washing	32(12.1)
	homemade disinfectants while	9.8% purchased from company/ manufacturers.

Majority of the farmers 53.4% diluted disinfectant with water before using, 34.5% washed formites and equipment

thoroughly and disinfect them, while 12.1% disinfect the

TABLE VI: VETERINARY CARE AND ASF PREVENTION (n=264)

QUESTIONS ASKED	RESPONSES	NO. OF RESPONDENTS
Pig introduction when they started manifesting the signs	After stocking with new ones	106(40.2)
	Before stocking	8(3.0)
	After exposure to pigs from other farms	60(22.7)
	After wild pig or wildlife incursion	12(4.6)
	After compromised biosecurity	69(26.1)
Age groups kept before the outbreak	After introduction of new feed	9(3.4)
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How many pigs died?	All of the above	36(13.6)
	Adult boar/sow	35(13.3)
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	Piglets	46(17.4)
Action taken to pigs during ASF outbreaks	All of the above	136(51.5)
	No actions	77(29.2)
	Slaughtered	84(31.8)
	Sold	82(31)
	Treatment	6(2.3)
	Disinfection	15(5.7)
Source of disinfectant used	Others	0(0)
	Home-made	38(14.4)
	Bought from veterinary pharmacy	97(36.7)
	Bought from open market	103(39)
	Directly from company/manufacturer	26(9.8)
Disinfecting procedures used	Thoroughly washed and disinfect	91(34.5)
	Mix disinfectant with water and use	141(53.4)
	Disinfect only without washing	32(12.1)

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VETERINARY CARE AND AFRICAN SWINE FEVER PREVENTION

More than half of the farmers (54.5%) reported ASF outbreaks to veterinary authorities. Among these, 47.7% received advisory support only, while 15.9% had their pigs treated by veterinary professionals. Notably, 36.4% of those who reported cases received no intervention. The majority of farmers (68.2%) expressed satisfaction with the veterinary services provided, whereas 31.8% were dissatisfied.

Regarding biosecurity measures, 70.5% of farmers reported adhering strictly to quarantine protocols. Approximately 71.6% were specifically advised to quarantine new or exposed pigs before reintegration with existing stock. Additionally, 58% of respondents were instructed on when to restock following an outbreak. The most commonly practiced quarantine duration was 4–6 weeks (54%), followed by ≥ 7 weeks (24%) and 1–3 weeks (22%). In terms of replacement stock sourcing, 79.5% of farmers obtained new pigs from other farms, while only 20.5% purchased from markets.

After depopulation, 44.3% of farmers allowed their farms to remain empty (“farrow”) for 1–2 months, 30.7% for 3–4 months, and 25% for longer than four months before restocking. (Table v)

DISCUSSION

The result of the seroprevalence of ASF in South-eastern Nigeria showed a total prevalence of 8.3%. The findings from this study where positive results were gotten from only Enugu State compared with Abia and Imo State were similar to Asambe *et al.* (2017) reported a seroprevalence rate of 13.6% and 2.8% in Benue states in the North region of Nigeria and Adenaike *et al.* (2023) obtained seroprevalence rate of 0.79% from Nasarawa State Nigeria receptively.

The presence of ASFV antibodies detected in pig in Enugu State could be due to the close proximity of Enugu State to Benue and Kogi States which have high seroprevalence of ASF (Payne *et al.*, 2021). These states practise extensive system of swine production which is a major factor responsible for increased risk of ASF.

Moreover, a strong relationship between Enugu State and these states in agri-business whereby farmers, butchers and middlemen move to livestock market in the states to buy or sale livestock and/or its products. Thereby having contact with ASFV infected pig or contaminated products. The absence of positive result from Imo and Abia could be that pigs are dying before seroconverting as this could have been an early-stage infection (OIE, 2012).

This may be also be attributed to the fact that farmers sell off their animals immediately they hear of ASF outbreaks, but suspected cases are collected, sold, poled together for slaughter hence increased chance of the antibody detection in the slaughter slabs (Atuhaire *et al.*, 2013). There is also a

possibility that there was no recent infection and outbreaks when the sampling was done. These results are in agreement with findings from Gallardo *et al.*, (2011) and Okoth *et al.*, (2013).

Furthermore, samples in this study might have been collected during post infection or after outbreaks when pigs were wiped out with disease or sickly pigs sold for slaughter.

The results of the study on demographics of the respondents showed male domination (74.6%) in pig farming in the study area. The reason may be due to high economic value of piggery farming compared to village poultry farming where women and children have been reported to dominate has been attributed to the laborious nature of management operations in pig farming (Aleme and Mitiku, 2015).

The high level of married population (65.9%) could be as a result of farmers looking for ways of increasing household size in order to assist in the day-to-day running of the enterprise as well as assisting in other activities carried out in the farm.

This finding is in concordance with the report by Jibowo (2012) that majority of the adult population involved in pig farming in our society consists of married people. Also according to Ani (2015), marriage has a direct relationship with family stability; therefore, the high percentage of married respondents suggested that the pig farmers were stable and able to make good business decisions.

Pig farmers in this study were mostly males, in their mid-40s (40.05±6.33 years). In addition, the average age of the farmers was 40.05 years with majority of the farmers being within the productive age thereby suggesting availability of physical strength and mental alertness required for vigorous demanding management practices. This finding is in agreement with the research by Uneze and Onugu (2012) who reported larger proportions (55.0%) and (63.3%) of males in pig production in both Abia and Anambra States, respectively. The result could be also due to the inability of some females to withstand the stress as well as high demands of commercial pig production in the area.

About 14.8% of the respondents had no formal education. This does not differ from earlier findings by Oluyole (2005) who reported that high level of literacy will enable farmers to adopt and use improved farm practices. A high level of literacy might positively influence the farm businesses. However, there is a need of incorporating ASF and animal health knowledge into the formal and informal education systems especially the primary level. This will enhance the sharing of proper information about ASF and animal health in the country.

Higher ASF awareness and knowledge base have been reported in Cameroon by Ngu *et al.*, (2020) and in Uganda by Chenais *et al.*, (2017). However, these findings are contrary to Adebayo and Sorungbe (2002) who reported

low ASF awareness among pig farmers in Agege Area of Lagos State.

This study revealed that 64.9% of the pigs were mixed breeds, which is lower than the 80% from the Ministry of Livestock annual report (MINEPIA, 2016). Breeding for resistance (mixed breed) is an age-long technological advancement in livestock disease management. According to Saka *et al.*, (2010), Stocking of resistant breeds has thus become a veritable recommendation for livestock farmers, especially for virulent (viral) diseases like ASF. For adequate production with high yield, enhanced swine breeds with high performance must be used.

The practice of sourcing foundation stock from fellow farmers has also been reported among pig farmers in Kaduna State according to Ajala *et al.*, (2007), where sourcing from pig markets and neighbouring farms formed the common practice. Sourcing of pigs from farms is also suggestive of a higher level of ASF sero-prevalence in herds with an external source of replacement stock. It also revealed a higher level of compromise in bio containment efforts, possibly due to more frequent human and vehicular movements as reported by Costard *et al.*, (2005) (Table III). The risk of ASF seropositivity was always higher in farms with an external source of replacement stock than an internal source with the work done by Awosanya *et al.*, (2015) who reported that external source pose a great risk for ASF.

Sharing of farm equipment was found to be a risk factor that is insignificantly associated with the presence of disease in south eastern Nigeria ($P=0.2708$) (Table IV). This was not in agreement with the report by Saka *et al.* (2010) and Fasina *et al.* (2010) that prior to introduction of ASF in a neighbourhood farm, spread of ASF might be accelerated by the habit of sharing farm equipment among different farms.

Feeding pigs with kitchen leftover containing pork (0.0501) and restaurants or hotels leftover containing pork (0.0135) (Table IV) were significant to the risk of ASF infection This is in agreement with the works done by Fasina *et al.*, (2012) and Gao *et al.*, (2021) that swill feeding is a cost-effective way of feeding pigs, but it can also pose a major risk factor for introducing ASFV into farms and new areas. According to Zu Ermgassen *et al.*, (2016) and Nuanualsuwan *et al.*, (2022), farmers can heat treat the swill before feeding it to pigs in order to mitigate the risk of ASFV transmission through swill feeding.

The presence of an infected farm in a neighbourhood was also significantly associated with the infection of farms ($P = 0.0362$). This is related directly to a local spread between and within pig farms and may occur through direct pig-to-pig contact, especially in scavenging populations, by spreading through fomites, and possibly by tick vectors which was also significant to the spread of ASF (Rivas *et al.*, 2010; Firestone *et al.*, 2011). (Table IV)

The farmers tend to present sick pigs for slaughter at abattoirs or within the farms first, without determining the cause of sickness, some of which may be ASF (Randriamparany *et al.*, 2005; Fasina *et al.*, 2010). Since the ASF virus is present in the tissues and body fluids of slaughtered sick pigs, massive environmental contamination and possible farm infection may result (Table V).

CONCLUSION

From this study: the seroprevalence of ASF is 8.3 in Enugu State and 0 in Abia and Imo States. The occurrence of ASF in the study area is more the mixed breed of pigs and those managed under the intensive system.

The awareness of ASF is high about 83% and most pig farmers heard about it from their fellow pig farmers. Most farmers reported that the outbreak on ASF is not linked to any particular season and they sold off or slaughter their pigs when infected with ASF.

The occurrences and spreads of ASF are portrayed to be associated with sharing of farm equipment, poor biosafety measures, breaching of quarantine conditions, feeding of swill to pigs.

RECOMMENDATION

Molecular studies should be carried out to determine genetic lineages of the virus prevalent in South Eastern Nigeria.

CONTRIBUTION TO KNOWLEDGE

The study determined the sero-prevalence of ASF in Enugu State to be 8.3. This is the first to be reported in the State and in South-Eastern Nigeria.

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