Original Research Article

Poultry Diseases Sero-prevalence and Biosecurity Risks Practices in Live Poultry Markets in Southern Kaduna, Nigeria.

ABSTRACT

The first HPAI outbreak in Africa and in Nigeria occurred in Kaduna State. The study investigated factors favoring the introduction and spread of highly pathogenic avian influenza and the prevalence of H5 subtypes, Newcastle and Gumboro diseases antibodies in live poultry markets in Southern Kaduna. One hundred and twenty-three questionnaires were administered to live poultry marketers and 230 blood samples were collected from poultry. Sera from these blood samples were analyzed using agar gel immunodiffusion test for Gumboro disease and hemagglutination inhibition tests for avian influenza and Newcastle disease antibodies. The mean chicken antibody titre and prevalence of Newcastle disease antibodies were 4.46 ± 0.25 $\log_2$ and 61.9% respectively. The avian influenza H5 subtype sero-prevalence rates in chickens and guinea fowls were 34.9% and 60.0% respectively with a chicken mean antibody titre of 3.90 ± 0.42 $\log_2$. Gumboro disease sero-prevalence rate in chicken was 58.6%. Cages were used by 42.6% of marketers though 66.0% use wooden cages. Marketers trading in markets with history of the outbreak of the highly pathogenic avian influenza were more likely to separate their poultry based on breed and species compared to those from markets without history of outbreak of the disease. Live poultry marketers engaged in risky biosecurity practices such as eating, selling, and purchasing of sick poultry which will increase the likelihood of introduction and spread of highly pathogenic avian influenza in live poultry markets. These practices together with failure to wash hands with water and soap increase the human exposure. The risk perception of live poultry marketers with history of AI outbreak was higher than for those without history of AI outbreak. The period of high sales of live birds were Christmas, New Year and Eid-el Fitr. Chickens and guinea fowls in live poultry markets sampled have been exposed to H5 subtype, Gumboro and Newcastle disease antigen. Practices such as selling, eating, and purchasing of sick birds are factors likely to enhance the introduction and spread of highly pathogenic avian influenza in live poultry markets. Government interventions have improved the risk perception of highly pathogenic avian influenza in the intervened markets. Hence there is need for intervention in other markets.

Keywords: *Biosecurity Risks, Live Poultry Markets, Nigeria, Poultry Diseases, Practices, Sero-prevalence, Southern Kaduna.*

1. INTRODUCTION

Local poultry (LP) which form more than 80% of the over 150 million poultry in Nigeria and represents a major protein source and a means of livelihood to villagers (1, 2). It also a means of saving to these farmers which is at risk of being lost to disease (1).

The local poultry industry which is well developed in Kaduna State is essential to the rural economy through provision of income, supplementary food and employment to the rural populace would be at risk of being lost from poultry diseases especially Newcastle disease and avian influenza.

Kaduna State, which has over 90 % of its local poultry being extensively raised is further risked by the practice of using poultry manure for crop farming which increases the exposure

of local poultry to commercial poultry disease. The farmlands provide a point of interaction between local poultry and poultry pathogens like Newcastle, Gumboro and avian infectious disease viruses from commercial poultry (3).

Live Poultry Markets (LPMs) are significant platforms of interaction between local poultry from different villages as they are conveyed to be sold at LPMs and taken home, (1) thereby accelerating the establishment of diseases in different communities by spreading to other markets and communities through contaminated equipment, bird, people, and vehicles (4).

The detection of avian influenza antibodies in apparently healthy local chickens in Kaduna during the 2006 HPAI outbreak raised fears that chickens may act as reservoirs thus maintaining and spreading avian influenza virus to commercial poultry (5).

The convergence of local poultry from different households and villages in LPMs implying the poultry disease status of local poultry in LPMs reflects the poultry disease status within the area. The poultry disease status is essential for development of a local poultry health management protocol for promotion of local poultry in Kaduna State. This study assessed the prevalence of Newcastle disease, Gumboro disease and avian influenza antibodies among local poultry Sothern Kaduna Senatorial district of Kaduna State, Nigeria.

2. MATERIAL AND METHODS

2.1 Study area

Kaduna State is in the Northwestern region of Nigeria bounded by latitude 10^0 and 11^0 North and longitude 7^0 and 8^0 East. The state shares borders with Zamfara and Niger states to the west, Katsina and Kano states to the north, Bauchi and Plateau states to the east and Nassarawa and the Federal Capital Territory to the south. The state has an area of about 48,473.2 square kilometers with a human population of 6.3 million engaged in crop farming, livestock rearing, trading, and fishing (6).

Kaduna State consists of 23 local government areas with an estimated poultry population of 5,200,000 with over 90% being local poultry (6). The study areas were live bird markets in eight Local Government Areas of Kaduna State namely Jaba, Jema'a, Kachia, Kaduna North, Kaduna South, Kaura, Sanga and Zango Kataf Local Government Areas.

2.2 Surveillance of Newcastle Disease, Gumboro Disease and Avian Influenza Antibodies

2.2.1 Sample Size

The sample size of 228 was determined using the prevalence of avian influenza of 18.2 % earlier determined by Obi and Ahmed (2008) in a previous study in LPMs in states that reported AI in Nigeria in the formula:

$$N = \frac{Z^2 PQ}{D^2} \text{ (Mahajan, 1997)}$$

Where: - N= Sample size; Z= (1.96); P = Prevalence; Q = 1-Prevalence; D= Allowable error.

2.2.2 Sampling frame

Multistage random sampling techniques was employed to represent all the LGAs in Southern Kaduna, daily, every other day and weekly LPMs. Based on the aforementioned sampling technique, the underlisted LPMs (LGA) sampled were Central Market LPM (Kaduna North LGA), Kwoi LPM (Jaba LGA), Kafanchan LPM (Jema'a LGA), Kachia Crossing LPM (Kachia LGA), Sokoto Road LPM (Kaduna North LGA), Manchok LPM (Kaura LGA), Railway Station LPM (Kaduna South LGA), Gwantu LPM (Sanga LGA) and Zonkwa and Katsit LPMs (Zango Kataf LGA) were selected as study LPMs and blood samples from chickens, guinea fowls, ducks, pigeons, and turkeys were collected between March and June, 2010. In each

of these markets, a total of 25 samples were collected proportionately depending on flock size of each poultry species.

2.2.3 Data collection

A structured questionnaire was administered to consenting live bird traders prior to sample collection. The questionnaire gathered information on fowl sellers' demographic data, poultry management, and disease poultry source and vaccination history.

2.2.4 Blood Samples collection

Blood samples were collected between March and June 2010. Local poultry were selected without replacement noting their age, sex, and any abnormal condition prior to sample collection. Two millilitre of blood collected through brachial vein of poultry using 21 G sterile hypodermic needles and 2 ml syringes carefully observing asepsis were allowed to clot at room temperature and sera obtained were stored at – 200 C until used for serology.

2.2.5 Detection of avian influenza antibodies by HI test

An alpha hemagglutination inhibition (HI) test was performed on all poultry sera using standard procedures recommended by OIE (7). The test antigen used was an inactivated H5 subtype–antigen while the positive serum was an H5N2 serum both prepared by Istituto Zooprofilattico OIE/FAO Laboratory for AI and NDV delle Venezie.

2.2.6 Determination of Newcastle disease antibodies titre

Newcastle disease vaccine (La Sota strain) obtained from the NVRI, Vom, Nigeria was used as antigen for the test while the positive sera used as control was obtained from the NVRI Avian Virology Laboratory. An alpha hemagglutination inhibition (HI) test was performed on all poultry sera using standard procedures recommended by Allan and Gough (1974).

2.2.7 Detection of Gumboro disease antibodies

Gumboro antigen was derived from affected bursae of chicken that died from natural Gumboro disease (GD). The bursae were removed, diluted 1:1 (w/v) with PBS (pH 7.6); ground with pestle and mortar and centrifuged. The supernatant was extracted and used as an antigen. A positive control and a known negative antiserum were incorporated in each test run. The AGID test for Gumboro disease was performed as recommended by Harai *et al.* (1972).

2.3 Live Poultry Sellers Biosecurity Risk to Avian Influenza

Selected live bird markets were identified by Local Government area, town/village and GPS co-ordinates and structured questionnaire administered.

Information regarding the management, biosecurity practices employed in the market, volume of trade, sources and destination of birds were sought. Additional information as regards the knowledge of the marketers on poultry diseases and their readiness to disclose outbreaks of poultry diseases, especially AI. Other questions were aimed at prices of birds at various levels of trade and the trade or otherwise in sick bird.

2.4 Data analysis

Data generated were entered into Excel spreadsheet and analyzed by descriptive statistics using Statistical Package for Social Sciences (SPSS) software. The frequency, mean and standard error of mean were calculated.

3. RESULTS AND DISCUSSION

3.1 Results

The revealed that the mean Newcastle disease (ND) titre of the 230 poultry sampled was 4.46 ± 0.25 $\log_2$ with a prevalence of 60.4% (139/230) though 41.3% (95/230) had titre < 4

log_2 with 23.0% (53/230) and 35.7% (82/230) having 4 – 6 log_2 and > 7 log_2 respectively. However, of the 157 tested for avian influenza H5 subtype antibodies, the mean H5 antibodies HI titre was 3.90 ± 0.415 log_2 with a prevalence 35.7% (56/157) and a prevalence of 50.9% (112/220) for Gumboro antibodies.

All exotic cocks sampled in the study had Gumboro antibodies (X^2 = 19.48; P=0.01) though prevalence of ND (X^2 = 14.62; P=0.06) and H5 AI (**X^2** = 11.00; P=0.03) antibodies among other chicken types varied (Fig. 1).

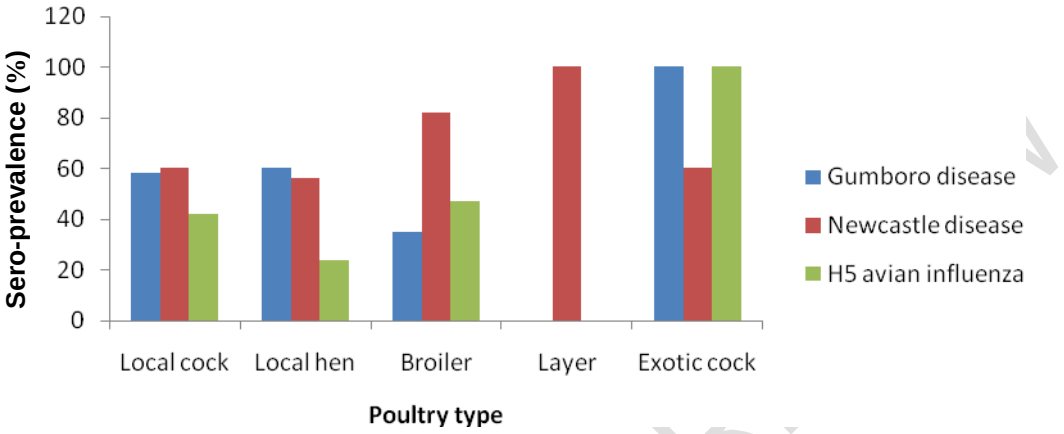


Fig. 1: Sero-prevalence of H5 avian influenza, Gumboro and Newcastle diseases among different chicken types

Poultry in Sokoto road LPM had 47.5% (19/40), 56.1% (23/41) and 42.9% (15/35) prevalence of Gumboro (X^2 = 23.74; p = 0.003), Newcastle disease (p>0.05) and H5 AI (X^2 = 27.50; p=0.024) antibodies respectively (Fig. 2).

Among the poultry species sampled, 61.9% (138) chickens were sero-positive for ND antibodies (X^2 = 10.02; P=0.007) while none of the six guinea fowls sampled had ND antibodies. The only turkey test was positive for ND antibodies. However, though not statistically significant (p>0.05), the prevalence of H5 AI antibodies in chickens and guinea fowls were 34.9% (53/152) and 60% (3/5) respectively. None of the guinea fowls and turkeys sampled had antibodies against Gumboro with a chicken prevalence of 52.6% (n=112; X^2 = 7.5; P= 0.024).

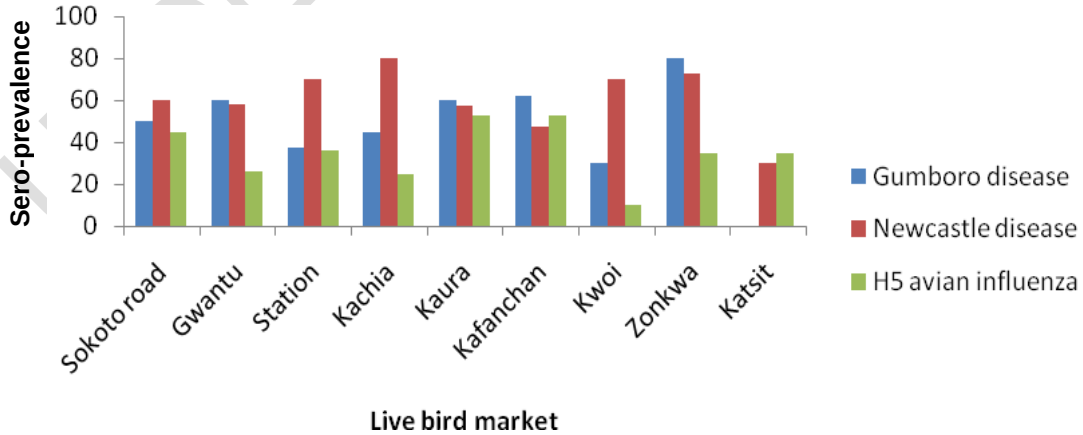


Fig. 2: Sero-prevalence of H5 avian influenza, Gumboro and Newcastle diseases in live poultry markets (LPMs)

Fifty six percent of live bird markets (LPM) studied were daily market with 43.6 % been weekly markets. The mean distance of LPMs from residential is 474.26 ± 27.60 m though the minimum distance was 0 m. However, 21.8 % and 66.2 % of LPMs were within 200 m and 500 m from residential areas though the maximum distance was 1KM.

Though 64.1 % (66/103) of respondents traded in LPMs without outbreak history, 56.4 % (57/101) operated in daily LPMs with 43.6 % (44/101) trading in weekly markets. Amongst respondents who indicated their market days, 52.3 % (23/44), 25.0 % (11/44) and 2.7 % (10/44) were Friday, Saturday and Thursday respectively. Seventy-five (74.3 %) respondents' LPMs were fenced with Kaduna being the town nearest to 19.8 % (20/101) of the respondents (Fig. 3).

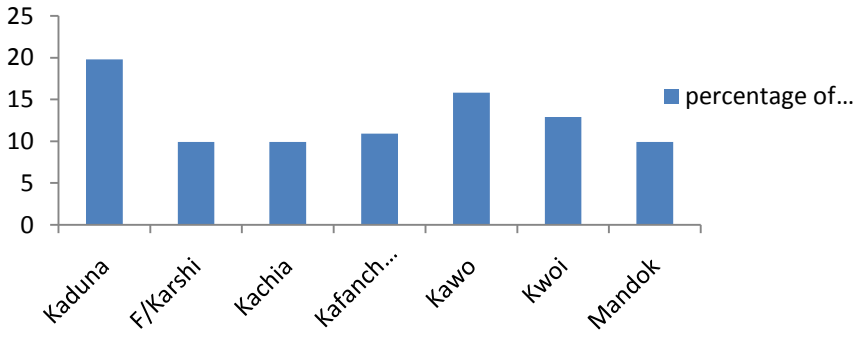
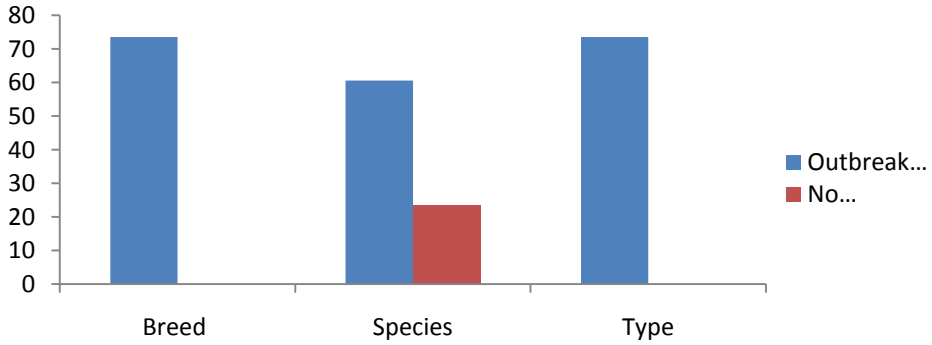


Fig. 3: Distribution of respondents nearest town

However, 42.6 % (43/101) of marketers kept poultry in cages with 34.0 (16/47) using metallic cages while 66.0 % (31/47) keeping poultry in wooden cages though only 9.9 % (10/101), 48.5 % (49/101), 32.7 % (33/101), 48.5 % (49/101) separate poultry by age, breed, species and type respectively. However, 73.5 % of respondents in LPMs with history of HPAI separate poultry by breed (Fig. 4). Daily LPMs (63.2%; X^2 = 43.18; P = 0.00) had outbreak history though LPMs without outbreak history (93.1 %; X^2 =49.08, P=0.00) practiced keeping poultry in cages though all LPMs without outbreak don't keep poultry in metallic cages (0 %; X^2= 7.42, P= 0.006). However, all LPMs with outbreak history separate poultry by age (100 %; X^2= 20.04, p = 0.00), breed (73.5 %; X^2 = 59.36, p = 0.00), species (60.6 %; X^2 = 13.31, P = 0.00), Type (73.5 %; X^2 = 59.36, p = 0.00). Similarly, all LPMs with outbreak history were fenced unlike those without outbreak history (13.3 %; X^2 = 63.21, p = 0.00).



Fig, 4: Relationship between history of HPAI outbreak in LPM and separation of poultry by breed, species or type

Sixty-five (64.4 %) of respondents reported that other animals are sold in their LPM with 11.8 % (10/85), 74.1 % (63/85), 76.5 % (65/85) and 42.4 % (36/85) selling cattle, sheep, goats and pigs respectively.

Most (59.4 %; X^2 = 53.14, p = 0.011) of respondents prepare sick poultry for food (Fig.5) though 38.6 % (39) and 54.5 % (55) respondents throw away dead poultry (Fig.6) and feathers respectively. However, 27 (66.7 %) poultry sellers acknowledged purchasing sick birds usually because they are cheap (Fig. 7) while amongst those who don't buy sick birds, only 9.9 % (7/71) did so because it was not safe (Fig. 8). Poultry offal are reported to be eaten by 78.2 % (79/101) of respondents (Fig. 9) while 95.0 % (95/100) use poultry manure in farms and 5 % (5/100) throw it away.

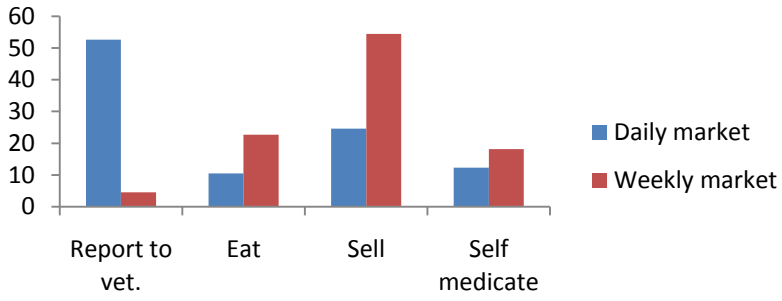


Fig. 5 Live poultry marketers' action on sick poultry amongst the types of LPMs

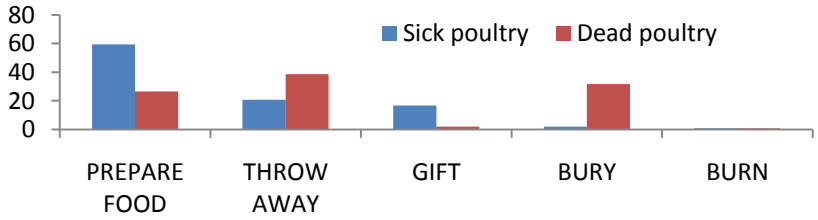


Fig. 6: Live bird marketers' practices on sick and dead poultry

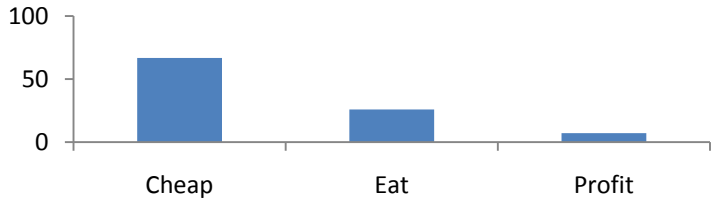


Fig. 7: Reasons live bird marketers give for buying sick poultry.

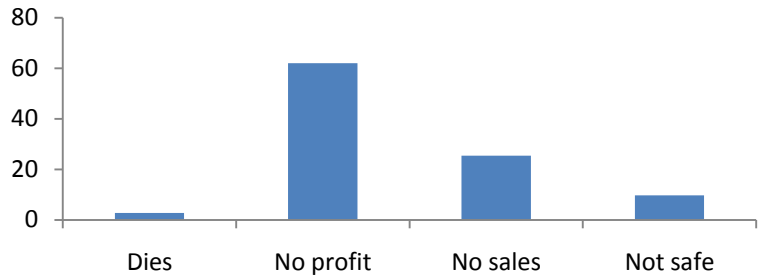


Fig. 8: Reasons live bird marketers give for not buying sick poultry

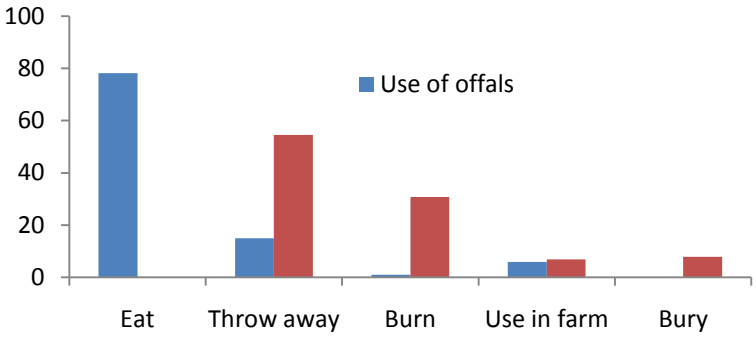


Fig. 9: Use of poultry offal and feathers among live bird marketers

All respondents in Kafanchan throw away all dead poultry while most in Kachia (80 %) would bury and 53.8 % of respondents in Kwoi would eat dead poultry (X^2 = 59.38, p = 0.002). However, in Kwoi, all respondents eat poultry offal though respondents in Sokoto road (12.5 %) and Kwoi LPM (40.0 %; X^2 = 40.63, p = 0.018).

All respondents in Sokoto road LPM burn poultry feather though most in Kachia LPM (70 %) use feather in farms while all respondents in Kaura and Kafanchan LPM would throw away feathers (X^2= 168.46, p = 0.00). Weekly markets are likely to throw away (77.3 %) feathers compared to daily marketers who either bury (10.5 %), burn (40.4 %) or use in farms (12.3 %; chi-square = 17.96; p=0.00).

Poultry feaces is used in farms by respondents in all studied LPMs except Kafanchan LPM (45.5 %; X^2 = 43.04, p = 0.00). Most respondents in crossing (80 %), Kafanchan (72.7 %) and Zonkwa (54.5 %; chi-square = 62.80, p = 0.00). Most respondents in Kaura (70 %) and Central market LPM (70.0 %; X^2 = 27.75, p = 0.001).

None of the respondents wear overalls, boots, face mask, hand gloves or goggles. All respondents in all the LPMs wash their hands after handling poultry except marketers in Crossing (20 %), Kafachan (27.3 %) and Zonkwa (45.5 %; X^2 = 62.8; p =0.00).

Though only 46.5 % (47) of respondents trade in LPMs having processing area, 23.4 % (11) reported that well was the source of water used in the processing and 53.5 % (54) using tap water though only 46.5 % (47) acknowledge that the LPM is regularly cleaned and disinfected. The processing area is usually cleaned by either LPMers (57.4 %) or processors (42.6 %). However, 55.3 % (26) of respondents reported that they drain water from the processing area into drainage channels while 44.7 % (21) drains into a river.

Live bird markets are either managed by local government staffs (54.5 %) or LPMers (44.6) or others (1 %) though only 46.5 % (47) acknowledged government intervention, though 48.9 % (23) listed building while 51.1 % (24) reported fumigation as government contribution. Respondents reported government intervention in Sokoto road, station, Kafanchan and central market LPMs ((46.5 %; X^2 = 101.00, p = 0.00) though intervention reported in Sokoto road LPM involved building while Station LPM was regular fumigation but central market LPM involved both building and fumigation (33.3 %; X^2 = 263.86, p = 0.00).

None of the respondents wear overalls, boots, face mask, hand gloves or goggles. However, 21.6 % (22) do not wash their hands after handling poultry.

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3.2 Discussion

The study confirmed earlier reports that ND is prevalent in chickens in Kaduna State (3) though the prevalence is lower than previous reports in local chickens in Kaduna State (3, 8). Though the exotic chickens were vaccinated, the source of the antibodies in local chickens might be due to either infection by field ND virus or from contact with vaccinal virus in the faces of the exotic chicken since poultry where not separated by type as reflected by the high proportion of chickens with titre >7 $\log_2$. The lack of protective ND antibodies in chickens could result in high mortality in these chickens upon infection with virulent field ND virus causing high mortality which can be confused with HPAI (9).

The study confirmed previous report that H5 subtype viruses are circulating in LPMs in Kaduna State (10). The antibodies might either be due to vaccination which is practiced illegally in commercial poultry or from challenge by field viruses. The antibodies due to vaccination would complicate surveillance as it will require the DIVA method thereby increasing cost of surveillance in Nigeria. However, antibodies might be due to infection with low pathogenic avian influenza (LPAI) since no clinical signs nor mortality were reported. Infection with LPAI in LPM calls for concern as these viruses have the potential of becoming HPAI after circulating in LPM as was the case in other outbreaks (11).

The prevalence of Gumboro disease (GD) among poultry confirms previous reports (3, 12). However, the absence of GD in broilers raises concern on the GD vaccination program practiced by commercial poultry farmers. The prevalence of H5 in guinea fowls calls for concern as they might act as bridge species and has a propensity of spreading the virus to distant unaffected areas and birds as the fly scavenging for food in farmlands. (13).

The study revealed that there are more weekly markets in the rural parts of Kaduna State than daily markets which were found in the urban and sub-urban areas. However, the LPM

were located close to residential areas which increases human, domestic pets and house pest exposure thereby making it difficult for control.

Since most weekly markets operates on Thursday, Friday, and Saturday movement restriction in case of outbreak would reduce the chances of spreading the infection by movement of infected poultry between markets. However, the lack of fence in most LPMs implies movement restriction into and out of the LPMs would be difficult with easy access by unauthorized persons and animals which increase probability of introduction and exposure to the HPAI virus.

The practice of using wooden cages makes cleaning and disinfection of the cages difficult with likelihood of contaminated cages not being properly disinfected and acting as the focus of infection to newly introduced poultry thereby maintaining the virus in the LPM. However, the improvement seen in the use of metallic cages is probably due the FGN intervention in some markets though separation of poultry based on age, breed, species and type needs to be improved (14). The better practice of separating poultry by age, breed and species in LPMs which experienced HPAI outbreak highlights the success of FGN intervention in area of training LPMers on biosecurity with respect to HPAI which was revealed in this study. The practice of separation by breed, species and type was common in LPMs that experienced than in LPMs without HPAI outbreak history because government interventions are mainly in the LPMs that experienced outbreaks which are also located in the urban areas hence increased access to avian influenza information. The fencing of LPM might have played a role in the LPMs not having outbreak. The sales of other animals in some LPMs are likely to expose these other animal species to avian influenza as cross species infections has been reported (14). However, sales of pigs in the LPMs are not recommended as they have been reported as the likely mixing vessel.

This study revealed that LPMers engaged in risky practices similar to those reported by previous studies in Nigeria would enhance human exposure and spread HPAI among poultry (15, 16). These risky practices are probably due to the level of HPAI risk perception amongst LPMers. Risky practices of selling sick poultry would spread the infection since most rural farmers increase their flock size through purchases from LPMs (16). The purchase of sick poultry by LPMers because it is cheap without contemplating on the risk indicate that more needs to be done on marketers risk perception vis-a-vis the livelihood of marketers. Also refusal of marketers to purchase sick birds will discourage the practice by farmers especially the local poultry farmers (16).

The study further confirm highlights previous reports of self-medicating sick poultry in an attempt to treat infected poultry which would likely increase environmental contamination with the AI virus if poultry is infected (16).

Throwing away of dead poultry also increases spread of H5N1 virus and environmental contamination while increasing the likelihood of infection of wild birds which serves as avian influenza reservoirs. These dead poultry thrown away could be carried away by scavengers which mechanically spread the virus to uninfected areas.

Preparing of sick poultry for food exposes the processors to the virus during processing and contaminates the environment and LPM.

The marketers in daily markets report sick poultry to veterinarians unlike those in weekly markets because government intervention are mostly in the daily markets which have a FSA and a biosecurity team which includes veterinary services personnel which they can readily access (Muhammed, 2010). However, marketers in the weekly markets would likely either

sell, eat or self-medicate their sick poultry compared to daily markets as marketers in daily markets are more informed on avian influenza risks from the numerous seminars, they have participated in organized by the State AICP (Muhammed, 2010).

Consumption of poultry offal increases risk of exposure of consumers to the HPAI H5N1 virus hence increases chances of human infection. However, marketers not burning offal rather either throwing it away or using it in farms increases access of these offal to scavengers like eagles, dogs, pigs and vultures which might either act as reservoirs or transfer to distant uninfected areas. Though marketers are likely to engage in the risky practice of throwaway feathers, than either burn or bury might be as a result the cost involved in these forms of disposal. Hence, the need to explore other forms of disposals such as composing of feathers, offal and dead birds which might serve as manure for farms while inactivating the HPAI H5N1 virus.

The practice of throwing dead poultry by marketers in Kafanchan highlights the need for education of these marketers on the risk of avian influenza and how proper biosecurity practices could protect their investment in the event of HPAI outbreak. However, the marketers in Kachia likelihood of burying dead poultry is probably based on their religious beliefs which does not encourage eating of dead animals though the marketers in Kwoi are more likely to be exposed to HPAI virus in the event of an HPAI outbreak. Similarly, marketers in Sokoto road burn all their feathers because of the availability of an incinerator in the market though the disposal of feathers by marketers in Kachia would expose both humans and environment to virus in an HPAI outbreak. The use of poultry faces by marketers with compositing would spread the virus and expose both human and animals, especially local poultry to HPAI virus.

The study revealed that marketers do not wear protective clothing, nor do they wash their hands during and after handling poultry which is likely to expose them to virus if poultry is infected.

The study revealed that there is need to update some of the LPM with processing section in terms of provision of tap water and proper drainage as these are essential for ensuring biosecurity of the LPM. The draining of processing area waste into rivers should be discouraged as this will spread the virus to new areas. Also, provision of water will ease daily cleaning and disinfection of the market, especially the processing sections.

The revealed more of the LPM studied were managed by Local Governments which made it a little difficult from benefiting from federal Government intervention as the marketers are supposed to proof ownership of the market as a requirement for partnership with FGN. The LG ownership of markets might reduce participation of marketers in the management and cleaning of the market which is the responsibility of government officials who do not have any interest at stake if markets are not properly cleaned. Also, there the sustainability of the fumigation and other intervention measures would not be guaranteed in the eventual withdrawal of government support.

Marketers in Kafachan could discourage contact of children with poultry by avoiding buying poultry from children as children are more susceptible to avian influenza. Though few marketers purchase sick poultry which is a risky practice, marketers in Kaura would be increasing human exposure since they consume the sick poultry while those in Sokoto road, Station, Kafachan, Gwantu and Zonkwa would encourage viral spread as they sell sick poultry to maximize profit.

The study revealed that most of the poultry has been sold to consumers who are end users though a reasonable sale is to vendors who take the poultry to other markets with possibility of dissemination of poultry infection to other poultry and markets. Weekly markets are mostly rural markets which serve as the primary markets where vendors purchase poultry to be sold in daily markets which are mostly located in the urban centers.

The study showed that Elil Firi and Easter are high sale periods which are associated with outbreaks of Newcastle disease and avian influenza. Hence surveillance should be increased, and veterinary service should be on the alert during this period. The different markets have different periods of high sales which could be utilized by surveillance teams in preparing timetable for HPAI surveillance.

The marketers in Kachia and Zonkwa LPMs should be encouraged to form FSA so that they could benefit from FGN intervention programs. Marketers in Kachia, Kaura, Kwoi, Zonkwa and Kaduna central market have poor knowledge in poultry diseases which might affect their disease reporting ability though this lack in knowledge might be as result of marketers buying only healthy poultry. However, Gumboro disease was known by marketers in some LPMs, ND was known by all marketers. The knowledge on ND might be because ND outbreaks are common, but this could be built on by encouraging them to report outbreaks as it's a differential to HPAI. Coccidiosis and fowl pox are other diseases encountered by marketers.

Poor awareness of HPAI in Kachia, Kaura and Zonkwa will hamper disease recognition and reporting though the high awareness in the other LPMs reaffirms the success of the AICP in creating awareness on HPAI among stakeholders. The study revealed that marketers in Sokoto road and Gwantu LPMs would recognize HPAI in case of outbreak enhancing the likelihood of swift reporting. However, the poor knowledge of the clinical signs might be because of radio being media of HPAI knowledge as reported previous studies and calls for the need to enlighten these marketers on HPAI recognition which will improve on HPAI disease reporting. This can be achieved by using audio-visual aids. The knowledge of marketers on HPAI differential was low.

The marketers in daily market would easily report outbreak as they know where to report HPAI outbreak. In these LPMs, the desk officers are members of the biosecurity team which justifies their willingness to report outbreak to veterinarians. However, the poor knowledge of marketers in weekly markets on where to report HPAI outbreak might be due to the lack of organization of their markets. This will reduce disease reporting by these groups of marketers which could be ameliorated by engaging community leaders in HPAI outbreak reporting.

Knowledge on the public health significance of HPAI was very poor among marketers which leads to poor risk perception which is reflected in the believe that HPAI does not infect humans. Marketers in urban and semi-urban areas were afraid of HPAI which indicate their high-risk perception due their exposure to more information on HPAI unlike marketers from LPMs in rural areas who have poor access to HPAI information. The study reveal that the trend of fear rate of marketers' family and colleagues was like those of local poultry farmers in a previous study.

4. CONCLUSION

In conclusion, the study, reveals that antibodies against H5 influenza, Gumboro and Newcastle disease virus were detected in various species; and live poultry markers engaged in practices that would increase likelihood of introduction and spread of poultry disease among poultry and humans. Local poultry were mostly marketed in the LPMs within the

study area and poultry of multiple ages, sexes, types are mixed in the weekly LPMs and most of the LPMs operate weekly, and all weekly markets are not fenced with only two LPMs have been upgraded and are fenced.

CONSENT

No manuscripts will be peer-reviewed if a statement of patient consent is not presented during submission (wherever applicable).

ETHICAL APPROVAL

Not Applicable

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