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# Demographic and management factors associated with biosecurity measure compliance on pig farms in south west Nigeria

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**Abstract**

Biosecurity measures are poorly or infrequently implemented in livestock farms. This study attempted to explore reasons for under-implementation of biosecurity in pig farms by determining demographic and management factors related to having good biosecurity score on 144 pig farms in south west Nigeria. A pretested and structured interviewer-administered questionnaire was used to obtain information on demographic and management factors, and on the biosecurity measures in place in the farms. A scoring system was developed to assess biosecurity measures, bivariate and multivariable analyses were done to determine predictors for good biosecurity score on the pig farms. The mean age of the respondents was 49.2 ± 14.6 years. Of the 144 respondents, only 35% had heard of the term biosecurity. The mean biosecurity score was 11.7 ± 2.2 and only 53 (37%) had good biosecurity score. In the bivariate analysis, the location of the farm [Odds Ratio (OR) = 1.9; 95% Confidence Interval (CI) 0.9 – 4.0], age of the pig farmer/ manager (OR = 2.2; 95% CI 1.0 – 4.9), years of practice (OR = 1.9; 95% CI 0.9 – 4.0) and pig mortality rate in the past 1 year (OR = 1.8; 95% CI 0.9 – 3.9) were significantly associated with good biosecurity score. In the multivariable logistic regression, only the age of farmer/ manager (OR = 2.8; 95% CI 1.3 – 6.2), farm size (OR = 2.4; 95% CI 1.1 – 5.2) and pig mortality rate in past 1 year (OR = 2.2; 95% CI 1.1 – 4.5) remained significant predictors of good biosecurity score. Factors such as age of farmer/ farm manager and farm size should be considered in the design and implementation of biosecurity on pig farms and in the process of encouraging adoption of pig farm biosecurity. Pig farm mortality rate could serve as an indicator of biosecurity level.

*Keywords*: Age, Farm manager, Farm size, Location, Mortality, Score

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## Introduction

Biosecurity measures are set of health controls and activities taken to prevent entry of new infectious diseases into animal herds and to avoid their spread through exit of the disease agent (Barcelo & Marco, 1998). FAO (2008) defines it as the implementation of measures that reduce the risk of the introduction and spread of disease agents; it requires the adoption of a set of attitudes and behaviors by people to reduce risk in all activities involving domestic, captive/ exotic and wild animals and their products or infection from a premise. According to Barcelo and Marco (1998), the most important biosecurity factors to consider in the prevention of new infections into animal herds are location, isolation or quarantine of replacement stock, and the conditions of the farm itself. It should be emphasized that all measures or items of biosecurity are necessary.

The effectiveness of biosecurity measures in the prevention and control of *Campylobacter* infection in commercial broiler flocks have been demonstrated (Gibbens *et al*., 2001). Biosecurity has also been reported to contribute to the control of *Salmonella* infection in pigs herds (Cook, 2004). Its roles in the prevention and control of diseases of equine (Weese, 2014) and cattle (Dargatz *et al*., 2002) have also been reported. It has been observed that many biosecurity measures are either partially observed or not observed at all owing to several factors such as costs, inadequate veterinary extension and attitudinal dispositions (Brennan & Christley, 2012). Studies have been conducted to gain insight into the perception of

pig farmers and veterinarians with regard to biosecurity measures (Casal *et al.*, 2007, Simon-Grife *et al*., 2013). Some researchers have made attempt to understand the relationship between biosecurity compliance and personality traits such as conscience (i.e. when a stakeholder in the farming industry is not being directly observed, how does his or her inner sense of what is right or wrong influence his adherence to biosecurity measures on the farm), and have evaluated strategies to improve biosecurity compliance on poultry farms (Racicot *et al*., 2012a, Racicot *et al*., 2012b). Attempts have also been made to quantify biosecurity level and identify its proponents (Pinto & Urcelay, 2003).

The pig farming industry in south west Nigeria is resident in one of the high pig density areas of Nigeria (FDL, 2010); and the industry can be classified into small holder farms with less than 50 pigs in the herd at any point in time, medium holder farms with 50 to 100 pigs in the herd at any point in time, and large holder farms with over a 100 pigs in the herd at any point in time. Apart from the challenges of relative high cost of feed (Ogunniyi & Omoteso, 2011), the industry also battles with infectious diseases such as neonatal mortality, salmonellosis (Abonyi *et al*., 2012) and African swine fever (Babalobi *et al.*, 2007, Fasina *et al*., 2010) among others. Some of these diseases could be effectively controlled by strict and proper implementation of biosecurity measures.

Previous workers in Nigeria have attempted to address the problem of partial or total neglect of some biosecurity measures on livestock farms. Fasina *et al.* (2012) corroborated the economic gains of effective implementation of biosecurity on pig farms in tackling the African swine fever scourge in Nigeria while Alhaji & Odetokun (2011) have assessed biosecurity measures on poultry farms through the risk of highly pathogenic avian influenza. There is a need to explore the reasons for inadequate compliance with biosecurity measures on pig farms in Nigeria in spite of the reported gains of biosecurity.

This study therefore aimed to determine demographic and management factors that are associated with good biosecurity score on pig farms in south west Nigeria.

## Materials and methods

*Study design*

The study was a cross sectional survey carried out between November 2012 and August 2013. Data were obtained from 144 pig farms across the six states in south west Nigeria. The number of farms used in this survey was obtained by using the sample size formula for survey study ($n = Z^2 p (1 - p) / E^2$) as described in Thrusfield (2007). Where Z is the reliability coefficient put at 1.96 and E the margin of error was at 10% at 95% confidence level. The proportion of pig farms with good biosecurity score (p) was set at 50%. This gave a minimum sample size of 96 farms; however, 144 farms were sampled for better precision. The registered pig farms from Lagos (150) and Ogun (124) were selected by simple random sampling. In the remaining four states without a sampling frame, at least 6 pig farms were selected from each of the 3 senatorial districts in the state.

*Questionnaire design and administration*

A structured questionnaire was designed to assess biosecurity measures (n = 22) on the pig farms arising from three thematic areas as described by Barceló & Marco (1998) which are location, isolation or quarantine of replacement stock, and the conditions of the farm. For location, four variables were considered to include presence of slaughter slabs within 1km radius of the farm; presence of rubbish site within 1km radius of the farm; presence of carcass disposal or burying site within 1km radius of the farm; and presence of other livestock or pets within 100m radius of regular pen (Barceló & Marco, 1998). For isolation or quarantine of replacement stock, two variables were considered to include presence of isolation or quarantine unit outside 100m radius of regular pen, and the period of time for isolation or quarantining of new pig arrivals either for less than four weeks or more. For conditions of the farm, 16 variables were evaluated; mostly biosecurity measures at the management level (Table 1). All of the variables have dichotomous responses. The questionnaire was pre-tested on seven pig farms from two locations not included in the study and the findings were used to improve the quality of the questionnaire. The questionnaire was interviewer-administered to pig farmers or the farm manager on their various farms. Compliance with biosecurity measures relating to distances were adjudged based on the farmers' responses and direct non-participant observation.

*Statistical analysis*

The data were entered into Microsoft Excel 2007 and normality assessed. Analysis was done using Epi-info version 3.5.4. A scoring system was developed for the 22 variables to determine the biosecurity level on pig farms adapted from Pinto and Urcelay (2003) with slight modification – Pinto and Urcelay (2003) based on the perceived importance of the biosecurity factor ascribed score of 0 or 2 and 0 or 1 if less important. However, in our design we ascribed equal weight to all the biosecurity components and maintained score of 0 and 1 all through the study. The presence or absence of each variable was scored either 1 or 0 based on the recognised protective or risk effect of such variable. For instance, the presence of slaughter slabs within 1km radius of farm increases risk of infection with pathogenic organism; so its

**Table 1**: Sample of survey questions asked 144 pig farmers/ managers to assess the on-farm adoption of biosecurity measures in south west Nigeria, 2013

| SN | Survey items | | |
|---|---|---|---|
| General Information | | | |
| 1. | Gender | Male | Female |
| 2. | Age (years) | | |
| 3. | Highest Educational level | | |
| 4. | Involvement in pig farming | Part time | Full time |
| 5. | Years of practicing pig farming | | |
| 6. | State of farm location | | |
| 7. | Location of farm | | |
| 8. | Farm size (plots) | | |
| 9. | Local government area | | |
| 10. | Farming system | | |
| 11. | Ages of pigs on farm | | |
| 12. | Total number of pigs on farm | | |
| 13. | Number of dead pigs in the past 12months | | |
| Biosecurity items | | Yes | No |
| 14. | Presence of slaughter slabs nearby or within 1 km radius of the farm premises | | |
| 15. | Presence of rubbish heap nearby or within 1km radius of the farm premises | | |
| 16. | Presence of carcass disposal or burying site nearby or within 1km radius of the farm premises | | |
| 17. | Presence of other livestock within 100m radius of regular pig pen | | |
| 18. | Presence of a quarantine or isolation unit outside 100m radius of regular pen | | |
| 19. | Quarantine or isolation of pigs for minimum of 4 weeks | | |
| 20. | Daily cleaning of working utensils or equipment with soap and water | | |
| 21. | Daily cleaning of the pen floor | | |
| 22. | Daily or weekly disinfection of pen floor | | |
| 23. | Presence of a functional foot dip at the entrance of the farm | | |
| 24. | Presence of a loading bay | | |
| 25. | Having specific clothing designated for farm work | | |
| 26. | Having specific foot wear designated for farm work | | |
| 27. | Feeding of untreated/ uncooked swill to pigs | | |
| 28. | Presence of farm register for movement of vehicles and personnel on the farm | | |
| 29. | Farm workers eat food/ snack while at work on the farm | | |
| 30. | Practice of a routine pest (rodent, fly, tick etc.) control | | |
| 31. | Carcass disposal by burning or deep burying | | |
| 32. | Share farm workers among fellow farmers | | |
| 33. | Share farming equipment among fellow farmers | | |
| 34. | Farm workers wear farm clothes outside of the farm | | |
| 35. | Augment feed with kitchen waste during feed scarcity | | |
| 36. | Monitor human or vehicular movement on farm | | |
| 37. | Presence of a designated area for eating on the farm | | |
| 38. | Offer assistance to fellow farmer when short on farm workers | | |
| 39. | Source of water supply to the farm | | |
| 40. | Frequency of use of disinfectants on the farm | | |
| 41. | Methods of handling dead pigs on the farm | | |
| 42. | Presence of a fence and gate | | |
| Others | | | |
| 43. | Have had a major disease outbreak on the farm in the past years | | |
| 44. | Have heard of the term Biosecurity | | |

presence being a risk is scored 0 and absence 1 – reverse scoring (Anon, 2015). On the other hand, the presence of isolation or quarantine unit outside 100m radius of regular pen is protective, thus its presence would be scored 1 and absence 0. The total obtainable score was 22, and the higher the score the indication of a better biosecurity level. A score greater than 12 was graded good, the cut off score which addressed our interest on those who implemented a little above 50% of all set of items.

Descriptive statistics was done and the associations between the considered demographic and management factors with biosecurity compliance level on the pig farms were assessed by determining the odds ratios. Statistical significance was determined by the Fisher's exact test at the 95% confidence level. Multivariable unconditional logistic regression was used to determine predictors for good biosecurity score controlling for other covariates at $P < 0.20$. Collinearity among predictors was assessed by the use of Chi square test for binomial variables. A manual forward selection method was used. The goodness of fit of the model was tested using the Pearson goodness of fit test. In the final models, only variables that were found to significantly affect the outcome at $P < 0.05$ were retained.

**Table 2**: Bivariate analysis of factors associated with biosecurity compliance on 144 pig farms in south west Nigeria, 2013

| Variables | Good compliance n = 53 (%) | Poor compliance n = 91 (%) | OR (95% CI) | P value |
|---|---|---|---|---|
| Location | | | | |
| Rural | 31 (58.5) | 39 (42.9) | 1.9 (0.9; 4.0) | 0.05* |
| Peri-urban | 22 (41.5) | 52 (57.1) | | |
| Farm size (plot) | | | | |
| Greater than 1 | 21 (39.6) | 24 (26.4) | 1.8 (0.8; 4.0) | 0.07 |
| Less than or equal 1 | 32 (60.4) | 67 (73.6) | | |
| Age of Pig farmer/ manager (years) | | | | |
| 19 – 40 | 22 (41.5) | 22 (24.2) | 2.2 (1.0; 4.9) | 0.02* |
| 41 – 80 | 31 (58.5) | 69 (75.8) | | |
| Gender of the Pig farmer/ manager | | | | |
| Male | 40 (75.5) | 68 (74.7) | 1.0 (0.4; 2.5) | 0.54 |
| Female | 13 (24.5) | 23 (25.3) | | |
| Highest Educational level | | | | |
| No formal education | 1 (1.9) | 4 (4.4) | Ref. | |
| Primary | 4 (7.5) | 9 (9.9) | 1.8 (0.1; 109.1) | 0.57 |
| Secondary | 15 (28.3) | 19 (20.9) | 3.1 (0.3; 165.7) | 0.30 |
| Tertiary | 33 (62.3) | 59 (64.8) | 2.2 (0.2; 113.5) | 0.42 |
| Involvement in Pig farming | | | | |
| Full time | 26 (49.1) | 50 (54.9) | 0.8 (0.4; 1.7) | 0.31 |
| Part time | 27 (50.9) | 41 (45.1) | | |
| Number of Pigs on farm | | | | |
| Less than or equal 50 | 30 (56.6) | 50 (54.9) | 1.1 (0.5; 2.3) | 0.49 |
| Greater than 50 | 23 (43.4) | 41 (45.1) | | |
| Years of Practice | | | | |
| Less than or equal 5 | 27 (50.9) | 32 (35.2) | 1.9 (0.9; 4.0) | 0.047* |
| Greater than 5 | 26 (49.1) | 59 (64.8) | | |
| Pig Mortality rate in Past 1 year (%) | | | | |
| Less than or equal 5 | | | | |
| Greater than 5 | 29 (54.7) | 36 (39.6) | 1.8 (0.9; 3.9) | 0.056* |
| | 24 (45.3) | 55 (60.4) | | |
| Ages of pigs on farm (months) | | | | |
| Less than or equal 12 | 15 (28.3) | 18 (19.8) | 1.6 (0.7; 3.8) | 0.17 |
| More than 12 | 38 (71.7) | 73 (80.2) | | |
| Have heard of the term Biosecurity | | | | |
| Yes | 21 (39.6) | 29 (31.9) | 1.4 (0.7; 3.0) | 0.22 |
| No | 32 (60.4) | 62 (68.1) | | |
| History of a disease outbreak | | | | |
| Yes | 7 (13.2) | 17 (18.7) | 0.7 (0.2; 1.9) | 0.27 |
| No | 46 (86.8) | 74 (81.3) | | |

*significant at p≤0.05

**Table 3**: Unconditional Logistic Regression of factors associated with biosecurity compliance on 144 pig farms in south west Nigeria, 2013

| Variables | OR | 95%CI | P value |
|---|---|---|---|
| Age of pig farmer/manager (years) | | | |
| 41 – 80 | 1 (ref.) | | |
| 19 – 40 | 2.8 | 1.3 – 6.2 | 0.01 |
| Farm size (plot) | | | |
| Less than or equal 1 | 1 (ref.) | | |
| Greater than 1 | 2.4 | 1.1 – 5.2 | 0.03 |
| Pig crude mortality rate in past 1 year (%) | | | |
| Greater than 5 | | | |
| Less than or equal 5 | 1 (ref.) | | |
| | 2.2 | 1.1 – 4.5 | 0.03 |

**Results**

*Demography and management parameters*

The mean age of the 144 respondents was 49.2 ± 14.6 years; the male to female ratio was 3:1. Almost all (97%) of the pig farmers or managers had at least primary education. Most (59%) of the pig farmers or their managers had been in the pig farming business for more than 5 years. Of the 144 pig farms assessed, about half (51%) were located in peri-urban areas. The small holder farms constitute more than half (56%) of the pig farms sampled. Most (68.8%) of the farming operations was on a plot of land or less. All the farms raised pigs in strict confinement. Few farms (23%) had young stock that were less than or just a year old. About 45% of the farms had mortality rate of less than or equal 5% in the past 1 year. Very few (17%) had experienced major disease outbreak in the past years. Only 35% of the respondents had heard of the term biosecurity.

*Factors associated with biosecurity compliance*

The biosecurity scores ranged from 6 to 17 points and assumed a normal distribution. The mean score was 11.7 ± 2.2. Of the 144 pig farms, only 53 (37%) had good biosecurity score. In the bivariate analysis, the location of the farm (Odds Ratio (OR) = 1.9; 95% Confidence Interval (CI) 0.9 – 4.0), age of the pig farmer/ manager (OR = 2.2; 95% CI 1.0 – 4.9), years of practice (OR = 1.9; 95% CI 0.9 – 4.0) and pig mortality rate in the past 1 year (OR = 1.8; 95% CI 0.9 – 3.9) were significantly associated with good biosecurity score (Table 2); however, the farm size, gender of the pig farmer/ manager, educational level, level of involvement in pig farming, the number of pigs on the farm, the ages of the pigs on the farm, having heard of the term biosecurity and having had history of disease outbreak were not statistically significant at $p \leq 0.5$.

In the multivariable logistic regression adjusting for other covariates that were significant at $P < 0.20$, the age of farmer/ manager (OR = 2.8; 95% CI 1.3 – 6.2), farm size (OR = 2.4; 95% CI 1.1 – 5.2) and pig mortality rate in past 1 year (OR = 2.2; 95% CI 1.1 – 4.5) remained significant predictors of good biosecurity compliance (Table 3).

**Discussion**

In the multivariable analysis, the age of pig farmer or manager, the size of the farm in terms of land size and pig mortality rate in the past 1 year are significant predictors for good biosecurity score. Farmers or managers who were young (i.e. between age 19 and 40) were three times more likely to have good biosecurity score than those who were older (i.e. than 40 years). This finding is similar to that reported by Sayers *et al.* (2013); that younger dairy farmers had higher likelihood to implement biosecurity measures than their middle-aged counterparts. This, however, is contrary to the findings of Schemann *et al.* (2011) who reported lower compliance in younger people (less than 25years) involved with horse keeping in Australia. The difference in the age categorization may explain the contrast in the compliance level. The same study reported the best compliance rate among age group 35 – 44 compared to other age groups. In addition, pig farming operations on more than 1 plot of land was two times more likely to have good biosecurity score than those on a plot of land or less. This is similar to the findings of Susilowati *et al.* (2011) and Sayers *et al.* (2013) who reported positive significant association between land area of the farm or farm size and adoption of biosecurity measures in poultry keeping and dairy farming respectively. The availability of space for few of the farmers ranging from few plots to hectares of land could have encouraged pig farmers and managers to keep good

biosecurity measures especially those measures requiring space such as proper citing of isolation or quarantine units 100m away from regular pen (Barceló & Marco, 1998); carcass disposal sites and adequate spacing should there be the presence of other livestock. More so, pig farms with mortality rate of less than or equal 5% were two times more likely to have good biosecurity score than those with more than 5% mortality rate. Biosecurity has been effectively used in the prevention and control of *Salmonella* infection in pigs herds (Cook, 2004) with expected consequent reduction in pig mortality. The finding of this study is a further attestation to the gains of biosecurity in reducing mortality on pig farms.

There was a marginal significant association in the bivariate analysis between farm location and good biosecurity score: farms located in rural areas were two times more likely to uphold good biosecurity measures. Probably due to availability of adequate space to implement biosecurity measures in the rural areas than in peri-urban areas: adequate land space has been associated with biosecurity adoption (Susilowati *et al*., 2011). Though location was no longer significantly associated with good biosecurity score after adjusting for other variables, its indirect association with biosecurity compliance via availability of adequate space is noteworthy.

The year of practice was also marginally significantly associated with good biosecurity score: farmers who are just starting the pig farming business or have spent less than 5 years in the business had twice higher likelihood to have good biosecurity score than those who have been on for more than 5 years. Racicot *et al.* (2012a) also reported an association between experience and biosecurity compliance on a poultry farm in Canada. The association between experience and biosecurity compliance is in consonance with our finding on the association between age and biosecurity compliance, where younger pig farmers were more likely to have good biosecurity score than the older ones. Though not always so, sometimes there is a correlation between age and years of experience as in this study. However, year of practice was no longer significantly associated with good biosecurity score on adjusting for other covariates, its correlation with age, a factor that remained significant after correcting for other covariates, is however worthy of mention.

In this study there was no statistical association between gender of farmer or manager, educational level, level of involvement in pig farming either on full time or part time basis and good biosecurity score. However, Racicot *et al.* (2012b) reported association between gender and biosecurity compliance on a poultry farm. More so, Susilowati *et al.* (2011) and Racicot *et al.* (2012a) reported a relationship between educational level and adoption of biosecurity measures on poultry farms. The high percentage of pig farmers with at least primary education in our study population might have obliterated the effect of any association between the various educational level and biosecurity compliance when compared to no formal education group. Schemann *et al.* (2011), contrary to the study finding, also reported an association between level of involvement and biosecurity compliance: those who are not involved commercially in horse keeping were more likely to have lower biosecurity compliance. The reason could be that among the study population irrespective of whether the commitment to pig farming is on full time or part time, most pig farmers take to pig farming to make some profits as against just as a hobby.

In addition, no significant association was observed between the numbers of pigs on the farm, ages of pigs on the farm, history of disease outbreaks on the farm and good biosecurity score. These findings are similar to that of Pinto & Urcelay (2003) who reported no association between herd size, age of pigs at sales and high biosecurity score in pig herds in Chile. Most production factors in pig rearing were not associated with high biosecurity score (Pinto & Urcelay, 2003). More so, in this study, there is no association between having heard of the term biosecurity and good biosecurity score. This could probably be due to poor perceptions of the term biosecurity by the farmers; relationship has been reported between perceptions and biosecurity measures taken on pig farms (Casal *et al*., 2007). The time and money involved in implementing some of the biosecurity measures might have obliterated the difference in the level of implementation between those who have heard of the term and those who have not. It is also possible that the source of awareness of the term might have excluded relevant information needed to illicit interest, adequate acceptance and proper implementation among the pig farmers. Cost and lack of relevant education by specialist in the field have been suggested as possible reasons for infrequent or complete absence of some biosecurity measures on livestock farms (Brennan & Christley, 2012).

This study may be limited by both interviewer and information biases. We mitigated these biases by the training of the interviewers used in this study and by triangulating – we designed the questionnaire in such a way that certain questions were deliberately repeated in different ways. These limitations were taken into consideration in the interpretation of the data.

The findings of this study revealed that the age of farmers or their farm manager, the farm size in term of land space and crude mortality rate less than or equal 5% are predictors for good biosecurity score. This information will find application in the design and implementation of biosecurity measures. The government can encourage pig farming on bigger land space by giving soft loan and by encouraging young men less than 40 years to take up pig farming. Professionals involved in extension services should consider these factors in the process of encouraging adoption of pig farm biosecurity. Pig farm crude mortality rate could serve as an indicator of biosecurity level.

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