# *Animal health professionals' knowledge, risk perceptions and preventive practices towards zoonotic infections in Nigeria: any challenging gap?*

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**Keywords**
Animal health professionals,
Preventive practices,
Public health,
Risk perception,
Zoonosis,
Nigeria.

**Summary**
This study was aimed to assess zoonotic disease knowledge, risk perceptions, and preventive practices of animal health professionals in Nigeria. Cross-sectional questionnaire survey was conducted on 582 participants and 529 responded. Collected data were analyzed by descriptive statistics and multivariate logistic regression models. The proportion of veterinarians (92.0%) which knowledge about zoonosis was much higher ($P < 0.001$) than that of para-veterinarians (32.4%). In contrast to para-veterinarians (46.2%), the majority of veterinarians (76.7%) perceived high risk of zoonotic infections during necropsy/tissue collections. Similarly, a much higher ($P < 0.001$) proportion of veterinarians (54.0%) considered hand washing before eating at work as effective way of risk mitigation, compared to para-veterinarians (25.0%). Professionals in large animal practice were less likely (OR 0.35; 95% CI: 0.16, 0.77) not to be engaged in satisfactory protective measures. These results constitute public health contributions to the risk mitigation information that may support measures for zoonosis prevention in Nigeria.

## *Conoscenza, percezione del rischio e pratiche per prevenire le infezioni zoonotiche tra coloro che si occupano di sanità animale in Nigeria*

**Parole chiave**
Percezione del rischio,
Pratiche preventive,
Professionisti della salute animale,
Salute pubblica,
Nigeria,
Zoonosi.

**Riassunto**
Questo studio valuta la conoscenza delle zoonosi, la percezione del rischio e l'uso di pratiche preventive in coloro che si occupano di salute degli animali in Nigeria. È stata condotta un'indagine trasversale su 582 partecipanti; mediante statistiche descrittive e modelli di regressione logistica multivariata sono stati analizzati i dati raccolti dai 529 questionari pervenuti. La percentuale dei veterinari (92,0%)che conosce le zoonosi è risultata essere significativamente ($P < 0.001$) più alta di quella dei para-veterinari (32,4%). La maggior parte dei veterinari (76,7%) e il 46.2% dei para-veterinari considerano elevato il rischio di contrarre infezioni zoonotiche durante le necroscopie o la raccolta di tessuti. Ugualmente, una percentuale più alta ($P < 0.001$) di veterinari (54%) rispetto ai paraveterinari (25,0%) giudica lavare le mani sul posto di lavoro prima dei pasti una soluzione efficace per ridurre il rischio. Coloro che sono impegnati in attività con i grossi animali adottano misure protettive inadeguate (0,35; 95% IC: 0,16; 0,77). Questi risultati possono contribuire a fornire informazioni sulla riduzione del rischio a supporto di misure per la prevenzione delle zoonosi in Nigeria.

## Introduction

Zoonoses are infectious diseases transmitted from vertebrate animals to humans (WHO/FAO/OIE 2004). Zoonoses have become more prominent in recent years with outbreaks of some emerging infectious diseases, such as severe acute respiratory syndrome, highly pathogenic avian influenza, and Ebola Virus Disease, leading to human deaths across many countries (Lau *et al.* 2010, Oladokun *et al.* 2012, Fasina *et al.* 2014). However, some are listed as endemic zoonoses and include brucellosis, rabies, human African trypanosomiasis, bovine tuberculosis, cysticercosis, echinococcosis and anthrax, (WHO 2006).

An emerging zoonosis is "a pathogen that is newly recognized or evolved, or has occurred previously but shows an increase in incidence or expansion in geographical, host or vector range"[1]. Endemic zoonoses, often neglected, are found throughout the developing world where conditions for their maintenance and spread exist, and may occasionally give rise to epidemics. They are associated with people living in close proximity to their animals, affecting not only the health of people in the poorest communities but also causing morbidity and mortality of their livestock (Maudlin *et al.* 2009). It has been estimated that around 60% of the infectious organisms pathogenic to humans are zoonotic and that 75% of the all emerging infectious diseases are zoonotic (Cleaveland *et al.* 2001, Taylor *et al.* 2001, Woolhouse and Gowtage-Sequeria 2005).

Animal health professionals are broadly trained to help prevent transmission of zoonoses; to promote public health through recognition and treatment of diseases in companion and food animals; and to educate clients about diseases that may be transmitted from animals to humans (Glickman 1992, Wohl and Nusbaum 2007). Because these professionals are often the first to have contacts with potentially infected animals during clinical investigations, they are at risk of contracting zoonotic infections and may serve as a bridge for disease entry into the human population (Wright *et al.* 2008, Dowd *et al.* 2013).

Some preventive practices, such as use of sanitizers and protective clothing, have been used by veterinarians in Nigeria to mitigate risks of infections, but their effectiveness depends on the risk perceptions and appropriate applications during veterinary procedures. For many years, veterinarians and associate staff have been recognized as being at high risks of many zoonotic infections at work, possibly as a result of the nature of exposures such as bites and scratches of animals. The proportions of veterinarians that contracted zoonotic diseases at work have been reported to be as high as 60-65% in two studies conducted in the UK and South Africa (Constable and Harrington 1982, Gummow 2003). While the literature is rich in documentation of particular circumstances elsewhere on protective practices against zoonotic pathogens, they tend to be restricted to disease-specific interventions (Sultana *et al.* 2009, Max *et al.* 2011), high-risk occupational settings (Rabinowitz *et al.* 2013, Odo *et al.* 2015), and responses to zoonotic outbreaks (Ferguson *et al.* 2006, Somrongthong *et al.* 2012). Results of previous studies on the subject matter in Nigeria have only highlighted the risk of exposures of farm workers and pet owners to zoonotic infections (Adesokan *et al.* 2013, Awosanya and Akande 2015). To-date, information in scientific literature on the levels of zoonotic infections risk perceptions and mitigation practices by animal health professionals in Nigeria have received surprisingly very little attention.

Understanding the infectious disease protective behaviours in animal health workers is important to inform effective first-line public health and preventive practices programs on zoonoses. Therefore, this study was aimed to assess knowledge and risk perceptions about zoonotic infections, and preventive practices of a subset of animal health professionals that work in the field in Nigeria. We hypothesize that demographic and professional specialization characteristics of animal health professionals cannot influence protective practices against zoonotic infections. We anticipate that our preliminary findings will help to identify challenging gap against zoonotic infections and assist the professionals and public health authorities to enhance strategies of zoonoses control and prevention programs in Nigeria.

## Materials and methods

### Study area and population

The study was conducted in the North-central zone of Nigeria. The zone comprised of six States and Abuja, out of the 36 States in Nigeria. Each State has its own Veterinary Services Directorate. The zone also accommodates three Veterinary Teaching Hospitals at the Universities of Abuja, Ilorin and Makurdi as well as the only National Veterinary Research Institute in Nigeria, located at Vom in Plateau State (Figure 1).

The target population was animal health professionals practicing in the study area within the survey period. It is made up of veterinarians (with Doctor of Veterinary Medicine degree as basic professional qualification) and para-veterinarians (with Ordinary National Diploma and/or Higher

[1] www.who.int/zoonoses/emerging_zoonoses/en.

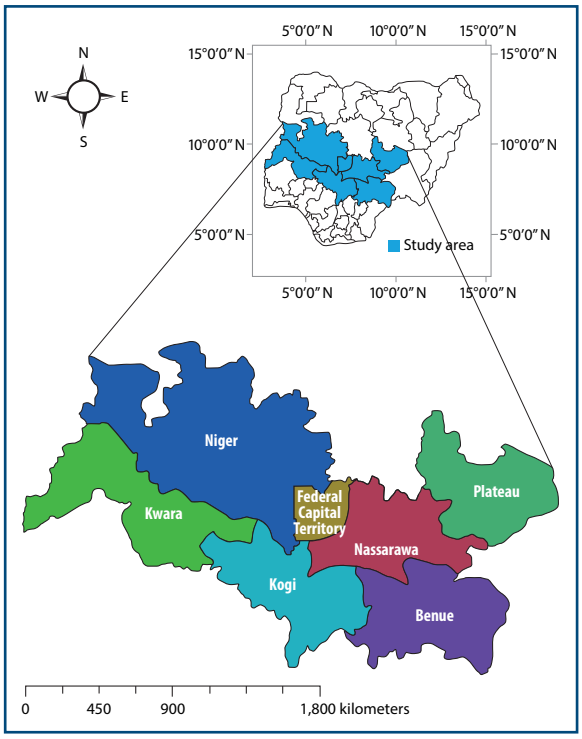


**Figure 1.** *Map of Nigeria showing location of the study area (north-central zone).*

National Diploma in animal health as basic professional qualifications), and all have had variable levels of professional training, skills and specializations.

## Study design and sampling procedure

A cross-sectional questionnaire-based survey was carried out on animal health professionals between October 2014 and September 2015 to collect information on knowledge and risk perceptions about, and preventive practices against zoonotic infections at work.

The sample size was calculated using the Epidat 3.1 software, with power set at 50% and margin of error at 5%. A 10% contingency was added to take care of non-response, and 582 target participants were chosen. The study population was obtained using a purposive sampling procedure because the sampling frame of the respondents in the zone was not readily available during the period of survey. The selected participants were the animal health professionals working in the livestock sub-sector (cattle, pig, sheep, goat and poultry farms), food-chain sector (slaughterhouses), veterinary clinics and hospitals, veterinary schools and research institute in the region. The procedures for this study were approved by the Niger State Ministry of Livestock and Fisheries Development Research Ethics Committee (protocol number MLFD/NGS/0672) of 19 February 2014.

## Questionnaire design, pretesting and implementation

The survey instrument, designed specifically for this study, was a 2-page structured paper based questionnaire developed in English, and contained mostly close-ended questions to ease data processing, minimize variation, and improve precision of responses (Thrusfield 2009). The questionnaire focused on various sub-themes like the respondents' demographic information and professional practice specialization; knowledge about zoonoses; risk perceptions on zoonoses at work; practices used for protection against zoonotic infections; and use of personal protective equipment (PPE) as preventive measures when performing veterinary procedures.

The sub-themes encompassed questions about respondents' general knowledge of zoonotic diseases and assessed by definition of zoonosis. Also, a list of infectious pathogens, diseases and syndromes was provided and respondents were asked to indicate those they believed are zoonotic, as well as the common routes for their transmission. Risk perceptions were assessed in terms of respondents' concerns on the risks of contracting zoonotic infections during veterinary activities. Practices were the protection measures, especially the use of PPE, against zoonotic infections at work. However, in Nigeria there is no standard guideline regarding the use of PPE against zoonotic infections. Assessment of inadequate or adequate PPE use in this study was therefore based on minimal (not ideal) PPE use recommendations by the American National Association of State Public Health Veterinarians, which are overalls/gown and gloves (Scheftel *et al.* 2010). In addition, we included cap and face mask.

The questionnaire was pre-tested prior to the study on few animal health professionals on whom the actual study was carried out and revised accordingly. The questionnaires were face-to-face administered on the respondents by the researchers. Before commencement of questionnaire administration, informed consent was verbally obtained from each respondent who was assured of voluntary participation, confidentiality of his/her responses and the opportunity to withdraw at any time without prejudice in line with the Helsinki Declaration (WMADH 2001). A total of 529 respondents in the various animal health practices completed and returned the questionnaires.

## Data management and statistical analysis

Data were summarized into Microsoft Excel 7 (Microsoft Corporation, Redmond, WA, USA) spreadsheet, exported and analyzed using Epi-Info 3.5.3 (CDC, Atlanta, USA). Descriptive and analytic

statistics were used to analyze variables, with frequencies and proportions predominantly used to described the obtained data.

Independent variables were created from the questions in the questionnaire about demographic and practice specialization characteristics, knowledge, risk perceptions, and preventive practices, while levels of protective practices constituted the independent (explanatory) variables. To create dependent (outcome) variables, a unique scoring system was used for the responses. Each respondent was assigned a score that reflected the stringency of his or her type of professional background. To measure responses to these independent factors, the scoring system ranged between 1 and 20 points and was converted to 100%. The score range was further categorized into 'poor' (≤ 10 points, ≤50%) and 'satisfactory' (≥ 11 points, ≥ 51%) to keep them as binary variables.

Associations between the outcome and explanatory variables were first subjected to univariable analyses using Chi-square tests (Dohoo *et al.* 2009). All factors found to be statistically significant were subsequently analyzed using likelihood stepwise backward multivariate logistic regression models to control for confounding and test for effect modification. A goodness-of-fit test using Hosmer-Lemeshow test was conducted and found that the final model was good. $P < 0.05$ was considered statistically significant in all analyses.

## Results

### Demographic characteristics of participants

During the one-year period of the survey, 529 (91.0%) of the 582 individuals who were approached completed the questionnaires. Therefore, a total of 529 animal health professionals, comprised of 25.9% (N = 137) veterinarians and 74.1% (N = 392) para-veterinarians, from the six States and Abuja in the North-Central Nigeria participated in the study. Median age of respondents was 38 years, with mean age of 40.06 ± 10.7 SD years. Forty percent of the respondents were between ages 30-39 years, while 84.2% were males and 15.8% females. A majority (89.7%) of the respondents was married; most (36.5%) engaged in general practice, and 2.3% specialized in wildlife practice (Table I).

### Knowledge level about zoonoses among animal health professionals

Knowledge level about zoonoses observed in veterinarians was significantly higher than in para-veterinarians. Similarly, the knowledge of veterinarians (92.0%) on the definition of zoonoses as diseases or infections transmitted from animals to humans, was significantly ($P < 0.001$) greater than that of para-veterinarians (32.4%). When provided a list of 11 infectious pathogens, diseases and syndromes, respondents were able to significantly classify just over half on their potentials to be transmitted from animals to humans. Higher ($P < 0.05$) proportions of the veterinarians gave correct classifications of dermatophytosis, bovine tuberculosis, brucellosis, rabies and highly pathogenic avian influenza as zoonoses compared to the para-veterinarians (Table II).

Regarding the modes of transmission of zoonotic diseases, which are through contacts with animal blood, contacts with aborted fetus and placenta, bites or scratches of animals, and contacts with carcasses/bodily fluid, the knowledge amongst veterinarians was significantly ($P < 0.05$) higher compared to para-vetarinarians (Table II).

### Risk perceptions for zoonotic infections at work

Animal health professionals were asked about their perceptions on the risk of exposures to zoonoses when performing veterinary procedures. There were high proportions of respondents that significantly perceived high risks of zoonotic

**Table I.** *Demographic and specialization characteristics of animal professionals in North-Central Nigeria.*

| Factor | Frequency N = 529 (%) | Veterinarians N = 137 (%) | Para-veterinarians N = 392 (%) |
|---|---|---|---|
| **Age** | | | |
| 20-29 | 79 (15.2) | 16 (20.3) | 63 (79.7) |
| 30-39 | 213 (40.3) | 54 (25.4) | 159 (74.6) |
| 40-49 | 122 (23.3) | 39 (32.0) | 83 (68.0) |
| 50-59 | 94 (17.8) | 22 (23.4) | 72 (76.6) |
| 60-69 | 21 (3.4) | 6 (28.6) | 15 (71.4) |
| **Gender** | | | |
| Male | 443 (84.2) | 102 (23.0) | 341 (77.0) |
| Female | 86 (15.8) | 35 (40.7) | 51 (59.3) |
| **Marital status** | | | |
| Married | 471 (89.7) | 114 (24.2) | 357 (75.9) |
| Single | 58 (10.3) | 23 (39.7) | 35 (60.3) |
| **Specialization** | | | |
| Small animal practice | 35 (6.6) | 11 (31.4) | 24 (68.6) |
| Large animal practice | 103 (19.4) | 25 (24.3) | 78 (75.7) |
| Poultry practice | 85 (16.1) | 32 (37.6) | 53 (62.4) |
| Wildlife practice | 25 (4.7) | 6 (24.0) | 19 (76.0) |
| General practice | 173 (32.7) | 30 (17.3) | 143 (82.7) |
| Abattoir worker | 108 (20.45 | 33 (30.6) | 75 (69.4) |


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infections when performing veterinary activities. Over half proportion of the veterinarians (61.3%) and para-veterinarians (55.4%) indicated that they perceived low risk of zoonotic infections when handling asymptomatic animals. However, the perception of the risk of zoonotic infections when handling of animals tissues/bodily fluid/excretions was greater (P < 0.05) amongst veterinarians (64.2%) than para-veterinarians (32.1%). Majority (76.7%) of the veterinarians reported high risk perceptions for zoonotic infections during necropsy/tissue collections, while less than half proportion (46.2%) of the para-veterinarians perceived such risk of infections for the procedures. This different perception was significant (P < 0.05) (Table III).

**Table II.** *Knowledge levels of animal health professionals on zoonoses in North-Central Nigeria: 2014-2015.*

| Variable | Type of profession | Yes N (%) | No N (%) | P-value |
|---|---|---|---|---|
| **Zoonosis is disease or infection transmitted from animal to human** | | | | |
| | V | 126 (92.0) | 11 (8.0) | < 0.001 |
| | P | 127 (32.4) | 265 (67.6) | |
| **Which of the following infections, diseases or syndrome is zoonosis?** | | | | |
| Dermatophytosis | V | 75 (54.7) | 62 (45.3) | 0.03 |
| | P | 173 (44.1) | 219 (55.9) | |
| Bovine tuberculosis | V | 112 (81.8) | 25 (18.2) | < 0.001 |
| | P | 103 (26.3) | 289 (73.7) | |
| Brucellosis | V | 119 (86.9) | 18 (13.1) | < 0.001 |
| | P | 141 (36.0) | 251 (64.0) | |
| Rabies | V | 102 (74.5) | 35 (25.5) | 0.001 |
| | P | 200 (51.0) | 192 (49.0) | |
| Anthrax | V | 81 (58.4) | 56 (41.6) | 0.01 |
| | P | 183 (46.7) | 209 (53.3) | |
| Hydatidosis | V | 78 (56.9) | 59 (43.1) | 0.03 |
| | P | 181 (46.2) | 211 (53.8) | |
| Gastro-intestinal worms | V | 52 (38.0) | 85 (60.0) | 0.59 |
| | P | 159 (40.6) | 233 (59.4) | |
| Distemper | V | 62 (45.3) | 75 (55.7) | 0.36 |
| | P | 161 (41.1) | 231 (58.9) | |
| Fowl pox | V | 57 (41.6) | 80 (58.4) | 0.64 |
| | P | 166 (42.3) | 226 (57.7) | |
| Infectious diarrhea | V | 57 (41.6) | 80 (58.4) | 0.63 |
| | P | 172 (43.9) | 220 (56.1) | |
| Highly pathogenic avian influenza | V | 109 (79.6) | 28 (20.4) | < 0.001 |
| | P | 169 (43.1) | 223 (56.9) | |
| **Common routes for transmission of zoonotic diseases** | | | | |
| Contacts with animal skin | V | 71 (51.8) | 66 (48.2) | 0.57 |
| | P | 214 (54.6) | 178 (45.4) | |
| Contacts with animal blood | V | 112 (81.8) | 25 (18.2) | < 0.001 |
| | P | 153 (39.0) | 239 (61.0) | |
| Consumption of animal products (milk and meat) | V | 89 (65.0) | 48 (35.0) | 0.001 |
| | P | 191 (48.7) | 201 (51.3) | |
| Contacts with aborted fetus and placenta | V | 114 (83.2) | 23 (16.8) | < 0.001 |
| | P | 157 (40.0) | 235 (60.0) | |
| Bites or scratches of animals | V | 119 (86.9) | 18 (13.1) | < 0.001 |
| | P | 161 (41.1) | 231 (58.9) | |
| Contacts with carcasses/bodily fluid | V | 116 (84.7) | 21 (15.3) | < 0.001 |
| | P | 195 (49.7) | 197 (50.3) | |

V = Veterinarians; P = Para-veterinarians.

## Practices used to protect against zoonotic infections at work

Animal health professionals that participated in the study were asked about zoonotic infection mitigation practices instituted against zoonotic infection risks at work, including use of PPE. Variable proportions of them indicated that they applied significant preventive practices that are related to hand hygiene, management of waste items or devices that have edges or projections, and barrier or isolation as mitigation practices against zoonotic infections (Table IV). Among veterinarians, 54.0% considered hand washing before eating at work as an effective way of reducing zoonotic disease risk, while only 25.0% of the para-veterinarians considered such activity effective. A significantly higher (P < 0.05%) proportion of veterinarians (78.8%) mentioned that they disposed needles in appropriate containers after use as a measure in reducing zoonotic disease risks, while less than one-third (29.3%) of the para-veterinarians engaged in such act. The practice of recapping needles prior to disposal was reported by a significant (P < 0.05) higher number of veterinarians (85.4%) as mitigation measure against zoonoses risks while just 46.4% of the para-veterinarians recapped needles before

**Table III.** *Animal health professionals' risk perceptions associated with zoonotic infections during veterinary procedures in North-Central Nigeria: 2014-2015.*

| Procedure | Type of profession | Low risk N (%) | High risk N (%) | P-value |
|---|---|---|---|---|
| Handle asymptomatic animals | V | 84 (61.3) | 53 (38.7) | 0.22 |
| | P | 217 (55.4) | 175 (44.6) | |
| Handle clinically ill animals | V | 50 (36.5) | 87 (63.5) | 0.02 |
| | P | 188 (48.0) | 204 (52.0) | |
| Handle dead animals | V | 56 (40.9) | 81 (59.1) | 0.001 |
| | P | 155 (39.5) | 237 (60.5) | |
| Handle tissues/ bodily fluid/ excretions | V | 49 (35.8) | 88 (64.2) | < 0.001 |
| | P | 266 (67.9) | 126 (32.1) | |
| Perform necropsy/ tissue collections | V | 32 (23.3) | 105 (76.7) | < 0.001 |
| | P | 211 (53.8) | 181 (46.2) | |
| Work in areas infested with ticks | V | 17 (12.4) | 120 (87.6) | < 0.001 |
| | P | 212 (54.1) | 180 (45.9) | |

V = Veterinarians; P = Para-veterinarians.

disposal. Only 13.8% of the para-veterinarians ($P < 0.05$) indicated they practiced sterilization of all equipment after use on affected animals to reduce risks of zoonoses unlike 48.2% of veterinarians that practiced such activity.

Nearly half (49.6%) of the veterinarians practiced washing and sanitizing of hands between patient contacts, conversely only one-third ($P < 0.05$) of para-veterinarians (34.4%) had such behaviour. Variable proportions of the respondents reported use of PPE when handling infectious procedures, isolations of suspected animals from apparently healthy ones, restriction of human contacts with suspected animals, and sterilization of all equipment that had been used on the suspected animals as mitigation measures against risks of zoonotic infections (Table IV).

## Use of PPE as protective measure against zoonotic infections at work

The levels of PPE worn in twelve different veterinary procedure situations are presented in Table V.

**Table IV.** *Animal health professionals' preventive practices used towards mitigating zoonotic infections at works in North-Central Nigeria: 2014-2015.*

| Practice | Type of profession | Yes N (%) | No N (%) | P-value |
|---|---|---|---|---|
| Washing hands with soap before eating at work | V | 74 (54.0) | 63 (46.0) | < 0.001 |
| | P | 98 (25.0) | 294 (75.0) | |
| Washing & sanitizing hands between patient contacts | V | 68 (49.6) | 69 (50.4) | 0.001 |
| | P | 135 (34.4) | 257 (65.6) | |
| Recapping of needles prior to disposal | V | 117 (85.4) | 20 (14.6) | < 0.001 |
| | P | 182 (46.4) | 210 (53.6) | |
| Sterilization and reuse of syringes & needles | V | 53 (38.7) | 84 (61.3) | 0.003 |
| | P | 100 (25.5) | 292 (74.5) | |
| Disposal of needles in an appropriate containers after use | V | 108 (78.8) | 29 (21.2) | < 0.001 |
| | P | 115 (29.3) | 277 (70.7) | |
| Routine isolation of suspected animals from healthy ones | V | 118 (86.1) | 19 (13.9) | < 0.001 |
| | P | 173 (44.1) | 219 (55.9) | |
| Restriction of people from having contacts with affected animals | V | 115 (83.2) | 23 (16.8) | < 0.001 |
| | P | 61 (15.6) | 331 (84.4) | |
| Sterilization of all equipment after use on the suspected animals | V | 66 (48.2) | 71 (51.8) | < 0.001 |
| | P | 54 (13.8) | 338 (86.2) | |
| Use of personal protective equipment when handling infectious procedures | V | 93 (67.9) | 44 (32.1) | < 0.001 |
| | P | 67 (17.1) | 325 (82.9) | |

V = Veterinarians; P = Para-veterinarians.

Interestingly, respondents reported the use of minimal PPE for seven of the twelve common practice scenarios assessed. Overall, they used PPE when examining sick animals as well as when handling potentially infectious specimens. Relatively high proportions of veterinarians and para-veterinarians (62.8% and 67.3, respectively) used adequate PPE when examining apparently healthy animals. However, 89.1% of the veterinarians and 58.4% of para-veterinarians consciously agreed that using adequate PPE when examining clinically ill animals was the effective way of reducing zoonotic infections. Among veterinarians, a significantly ($P < 0.05$) higher proportion considered use of minimal PPE for protection against zoonotic infections when handling placenta and fetal discharges, performing post mortems, and disease outbreaks investigations, respectively as inadequate, while the majority of the para-veterinarians considered minimal PPE use for these practice scenarios to be adequate.

Despite the likely zoonotic diseases risks, most of the veterinarians and para-veterinarians considered minimal PPE use for handling skin lesions, gastro-intestinal conditions, neurologic conditions, and animal faecal samples, as adequate for protection against risks of zoonotic infections. Conversely, 67.2% and 86.1% of the veterinarians considered use of PPE for protections when handling respiratory conditions and blood samples from suspected animals, respectively to be inadequate. On the other hand, the majority of the para-veterinarians (58.9 and 51.8%, respectively) considered the PPE use for same activities to be adequate.

## Associations of demographic and specialization characteristics with the levels of preventive practices against zoonotic infections

The demographic and specialization characteristics of the respondents were compared with their overall preventive practice behaviours to determine possible associations. Univariate analysis identified four independent factors and all, except gender and marital status, were significantly associated with the satisfactory preventive practices against zoonotic infection risks.

At the multivariate logistic regressions, age and specialization characteristics remained significantly associated with preventive practices. However, those in age group 50-59 years were nine times more likely (OR 8.99; 95% CI: 4.39, 18.44) to practice satisfactory preventive measures against zoonotic infections than those in age group 20-29 years. Also, professionals that specialized in large animal practice were less likely (OR 0.35; 95% CI: 0.16, 0.77) not to practice satisfactory protective measures

against zoonotic infections than those in small animal practice. However, those that specialized in abattoir work and wildlife practices were not likely to practice significant satisfactory preventive measures against zoonotic infections (Table VI).

## Discussion

Knowledge and perceptions about risks of zoonotic infections among high risk groups as well as controlling their transmission are crucial to the animal health profession. This study is unique because it was the first to broadly identify the use of minimal protective equipment during veterinary procedures for protection against zoonotic infections and integrates demographics and specialization to preventive practices against zoonotic diseases in Nigeria. The results of this study indicate that a significant higher proportion (92.0%) of the veterinarians had knowledge about zoonoses as compared to the para-veterinarians (32.4%). Good knowledge of zoonoses gives better understanding and perceptions of their risks. We found that considerable proportions of respondents could not significantly classify some pathogens as zoonoses. As previously reported, some gastro-intestinal worms can be zoonotic pathogens, such as *Toxocara canis* (Bingham *et al.* 2010). Also, most respondents did not possess significant knowledge about less severe but more common zoonotic syndromes, such as infectious diarrhea. However, most ($P < 0.05$) participants demonstrated knowledge about the potentials of bovine tuberculosis being transmitted from cattle to human.

Although there were general significant knowledge levels about routes of zoonotic disease transmissions, a significant lower proportions of the para-veterinarians had knowledge about pathogen entries, which is likely to expose them to risks of contracting zoonoses at works, as they are unlikely to take proper precautions or use protective barriers when dealing with high risk conditions such as abortions and placentas. One challenge for reducing human public health diseases burdens is the understanding of variable transmission routes of zoonotic pathogens, such as

**Table V.** *Use of minimal PPE as protective measures against zoonoses during veterinary procedures by animal health professionals in North-Central Nigeria: 2014-2015.*

| Procedure | Type of profession | Inadequate PPE kit N (%) | Adequate PPE kit N (%) | P-value |
|---|---|---|---|---|
| Handling apparently healthy animals | V | 51 (37.2) | 86 (62.8) | 0.33 |
| | P | 128 (32.7) | 264 (67.3) | |
| Handling clinically ill animals | V | 15 (10.9) | 122 (89.1) | < 0.001 |
| | P | 163 (41.6) | 229 (58.4) | |
| Handling skin lesions | V | 60 (43.8) | 77 (56.2) | 0.84 |
| | P | 168 (42.9) | 224 (57.1) | |
| Handling respiratory conditions | V | 92 (67.2) | 45 (32.8) | 0.001 |
| | P | 161 (41.1) | 231 (58.9) | |
| Handling gastro-intestinal conditions | V | 57 (41.6) | 80 (58.4) | 0.42 |
| | P | 148 (37.8) | 244 (62.2) | |
| Handling neurologic conditions | V | 44 (32.1) | 93 (67.9) | 0.46 |
| | P | 113 (28.8) | 279 (71.2) | |
| Handling animal faecal samples | V | 68 (49.6) | 69 (50.4) | 0.31 |
| | P | 175 (44.6) | 217 (55.3) | |
| Handling animal urine samples | V | 77 (56.2) | 60 (43.8) | 0.005 |
| | P | 167 (57.4) | 225 (22.6) | |
| Handling animal blood samples | V | 118 (86.1) | 19 (13.9) | < 0.001 |
| | P | 189 (48.2) | 203 (51.8) | |
| Handling placenta and fetal discharges | V | 126 (92.0) | 11 (8.0) | < 0.001 |
| | P | 139 (35.5) | 253 (64.5) | |
| Performing post mortems | V | 111 (81.0) | 26 (19.0) | < 0.001 |
| | P | 159 (40.6) | 233 (59.4) | |
| Disease outbreaks investigations | V | 88 (64.2) | 49 (35.8) | < 0.001 |
| | P | 121 (30.9) | 271 (69.1) | |

V = Veterinarians; P = Para-veterinarians.
Minimal PPE (personal protective equipment) are coverall clothing, hand gloves and boots.

**Table VI.** *Animal health professionals' demographic and specialization characteristics associated with preventive practices against zoonotic diseases risks in North-Central Nigeria: 2014-2015.*

| Factor | Poor practice 319 (60.3 %) | Satisfactory practice 210 (39.7 %) | Odds ratio | 95% CI | P-value |
|---|---|---|---|---|---|
| **Age** | | | | | |
| 20-29 | 65 (82.3) | 14 (17.7) | 1.00 | | |
| 30-39 | 138 (64.8) | 75 (35.2) | 2.52 | 1.33, 4.80 | 0.003 |
| 40-49 | 75 (61.5) | 47 (38.5) | 2.91 | 1.47, 5.76 | 0.001 |
| 50-59 | 32 (34.0) | 62 (66.0) | 8.99 | 4.39, 18.44 | <0.001 |
| 60-69 | 9 (42.9) | 12 (57.1) | 6.19 | 2.19, 17.50 | 0.001 |
| **Specialization** | | | | | |
| Small animal practice | 15 (42.9) | 20 (57.1) | 1.00 | | |
| Large animal practice | 70 (68.0) | 33 (32.0) | 0.35 | 0.16, 0.77 | 0.01 |
| Poultry practice | 54 (63.5) | 31 (36.5) | 0.43 | 0.19, 0.96 | 0.04 |
| General practice | 113 (65.3) | 60 (34.7) | 0.40 | 0.19, 0.83 | 0.02 |
| Abattoir worker | 52 (48.1) | 56 (51.9) | 0.81 | 0.37, 1.74 | 0.59 |
| Wildlife practice | 15 (60.0) | 10 (40.0) | 0.50 | 0.18, 1.42 | 0.21 |

influenza viruses, *Mycobacterium bovis, Salmonella* and *E. coli*, among others (Meslin 1997, Taylor *et al.* 2001). The lack of knowledge can be alleviated by facilitating communications and inter-disciplinary collaborations on research (Coulibaly and Yameogo 2000). Non availability of educational materials on zoonotic diseases in the veterinarians' specialized practices has been reported to be a cause of poor knowledge on zoonoses (Lipton *et al.* 2008).

This study observed a significantly higher proportions of animal health professionals to be having high risk perceptions of zoonotic infections during examination of sick animals or when handling some products. Despite the relatively variable levels of knowledge about zoonoses, these professionals still perceived high level of risks of exposure to zoonotic diseases during veterinary procedures. Perception of high risks of zoonotic infections was an important driver for adequate use of preventive measures. This logically concurs with the established theories of health behaviour, such as the protection motivation theory, which suggests that perceived risk influences motivation to take protective actions (Rogers 1975). Our finding on high risk perceptions by respondents was in concordance with a previous report that animal health workers in Tanzania perceived significant high level risks of exposure to zoonotic diseases at work (Swai *et al.* 2010). However, a survey of 344 Australian veterinarians found about half of them to perceived low risk level of exposure to zoonotic diseases (Dowd *et al.* 2013). A study has shown that veterinarians are particularly at higher risks of exposures to emerging infectious zoonoses than other animal health workers because of their contacts with sick animals on daily basis (Jackson and Illaroel 2012).

The present study has observed significant variable proportions of respondents' behaviours towards preventive practices against zoonotic infections, especially the use of barriers like PPE, during veterinary procedures. Most of the respondents indicated that they often wash their hands before eating at their work places. The proportion of respondents who reported always washing their hands prior to eating at work was lower among para-veterinarians; and barely half of the veterinarians reported engaging in this protective behaviour. Promotion of practice policies that require hand washing and separation of eating areas from animal practice areas is required. The study found high proportion (85.4%) of veterinarians and less than half (46.4%) of the para-veterinarians engaged in recapping of needles prior to disposal. In veterinary medicine, practices of reuse of washed and recapped needles and syringes which present a preventable risk for exposures to pathogens are common. Sensitization is needed to promote awareness on appropriate preventive practice of avoiding recapping of needles for another use among veterinary practitioners (Vaughn *et al.* 2004).

The study found use of minimal PPE during high risk veterinary procedures, like respiratory conditions and handling of fetal discharges and placentas, to be inadequate among veterinarians. Minimal PPE is dangerous for protection against emerging and re-emerging zoonotic infections because small droplets or aerosols of body fluids can be released during their handling (Pappas *et al.* 2005). Minimal PPE use is only adequate during examinations of apparently healthy animals and perhaps clinically ill animals presented for routine check-up. Veterinarians, due to the nature of training received and daily high risk veterinary procedures, are expected to use complete PPE kits (Dowd *et al.* 2013). Adequate protective practices reduce human exposure to zoonotic pathogens as previously reported (Weese 2002, Odo *et al.* 2015). As earlier stated, there is no official zoonotic infection control guidelines for veterinary practice in Nigeria. However, these guidelines are needed for protections against emerging and re-emerging zoonotic pathogens, such as Ebola and Lassa viruses, which are potentially transmitted through contacts with blood. Threats of emerging blood-borne pathogens should be seriously considered by the veterinary profession (Bermejo *et al.* 2006). It has been reported that awareness and education are significant factors that can influence the use of PPE (Dowd *et al.* 2013). The shortfall in the use of comprehensive PPE by animal health professionals in Nigeria, especially in the face of emerging and re-emerging zoonoses, should be adequately addressed through trainings. This could be given a priority at the annual Continuing Education Programmes organized by the Veterinary Council of Nigeria, Veterinary Schools and Colleges of Animal Health in the country.

Despite the proportional low levels of knowledge and marginal risks perceptions achieved by the para-veterinarians in this survey, all the age groups still practice significant satisfactory protection behaviours against zoonotic infections. Similarly, a significant lower number of professionals who are into large animal, poultry, and general practice specializations practiced satisfactory protective measures than those who were engaged in small animal practice. This is in consonance with the reports of a study in US in which fewer large animal and equine veterinarians were always engaged in protective practices at work than small animal practitioners (Wright *et al.* 2008). Thus, educational initiatives that are tailored toward different specializations adopting adequate preventive measures at work are warranted.

The results of this study were subject to limitations. The samples were selected from pools of animal

health professionals by non-probability approach, which may not be representative of these professionals in Nigeria. Although it is conventional to apply purposive sampling in epidemiological studies, it does affect the external validity of the nature of this study type. However, the distribution of respondents by state in the study zone was similar to the expected distributions across other zones in the country, suggesting that the sample size was reasonably representative of animal health professionals in Nigeria. If a selection bias was present, it is expected that the presented results would represent a 'best case'. Also, this study was well-complemented by qualitative data obtained through responses from interviews that formed basis for dependent variable scores. These were useful in evaluating the knowledge and risk perceptions on zoonotic infections and protective practices against exposure to zoonotic pathogens, and the perceived benefits of engaging in such practices.

## Conclusions

This investigation forms part of the evolution of identifying and reaching the health professionals at risks of zoonotic diseases. It collected preliminary information on knowledge and risk perceptions about, as well as preventive practices against zoonotic infections, which constituted public health contributions that may support future preventive education on emerging and re-emerging zoonotic diseases among vulnerable professions in Nigeria. Most of them neither possessed adequate level of knowledge about zoonoses nor applied adequate personal protective equipment at work, which are the most challenging critical gap in the face of zoonotic infections. Active methods, such as ongoing staff training, proactive role of educating clients on prevention of zoonotic infections, collaborative education relationships on knowledge and prevention of zoonotic infections between veterinarians, human public health professionals and physicians should be encouraged in Nigeria. Thus, stronger partnerships of animal health with public health agencies and other health professionals in this endeavour are needed in the spirit of 'One Health'. As emerging zoonoses become increasingly prevalent, it will be imperative for the veterinary profession to design standard protective practice guidelines in Nigeria. In doing so, the important role of the veterinary profession as a primary line of defense against the spread of zoonotic diseases will be further highlighted.

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